# DESCRIPTIVE ACCOUNT AND CATALOGUE OF THE HOME OFFICE INDUSTRIAL MUSEUM AND EXHIBITS



WITH EXPLANATORY NOTES

*THIRD EDITION*

LONDON
PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE
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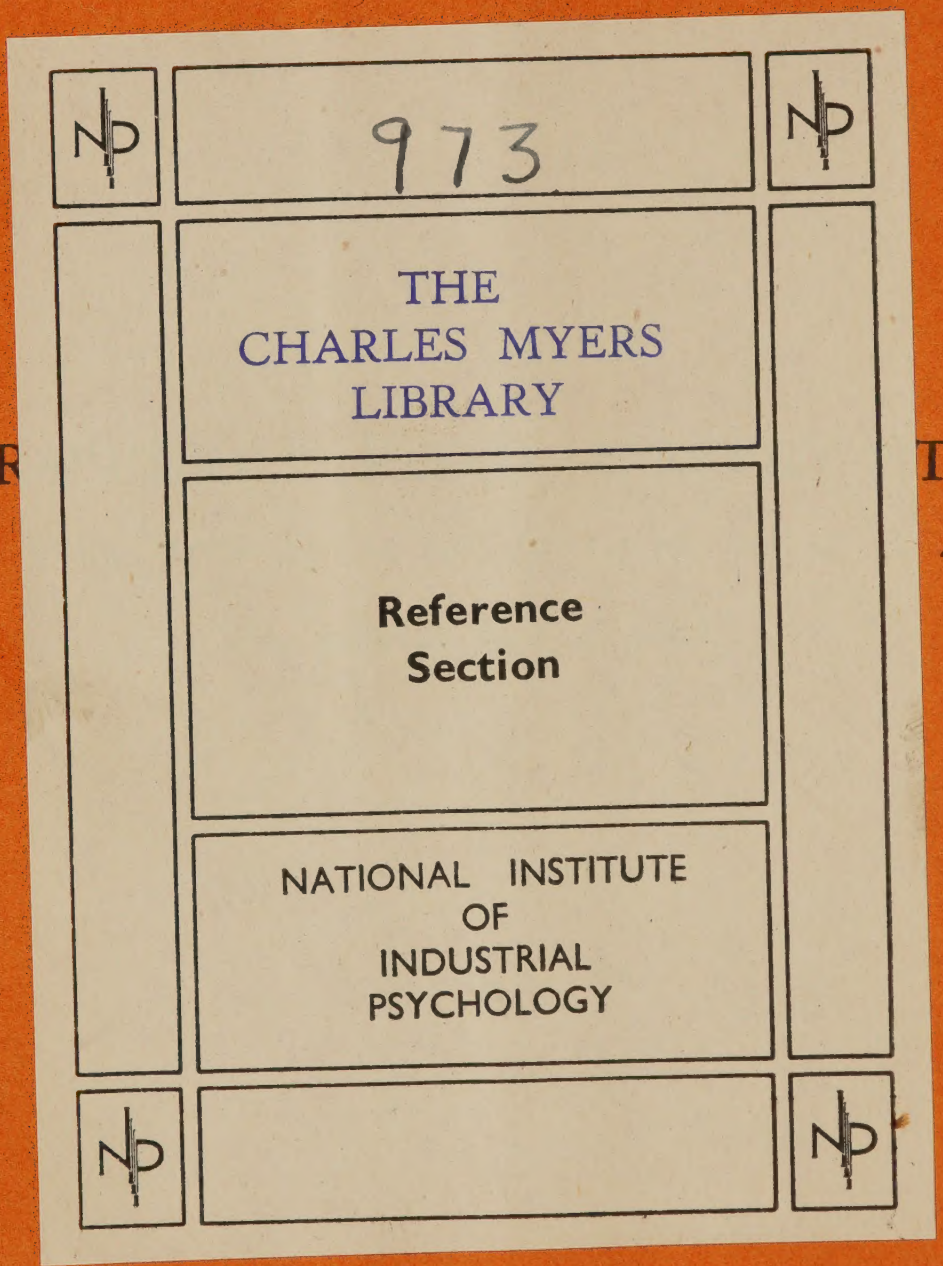


HOR TER.

Open 4 p.m.

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# FOREWORD.

By The Right Hon. Sir William Joynson-Hicks, Bart., M.P.,
*Home Secretary.*

The opening of the Home Office Industrial Museum, in Horseferry Road, has aroused so much interest and the opinions expressed from many quarters as to its usefulness have been so favourable, that I venture to hope and ask that this volume which explains the need for, and the principles underlying, the methods and arrangements illustrated in the Museum, may have a wide circulation. The volume will be found to be much more than a mere catalogue or descriptive account of exhibits. It contains a mass of information on questions of safety, health and welfare in industry, and, while in no way pretending to be exhaustive, it gives in a concentrated form much of the experience which has been gathered by the Home Office over a long period of years. It may be claimed that it goes some way to supplying what at present does not appear to exist, namely, a text book on industrial safety, health and welfare, so far as the factories of the country are concerned; and I commend it not only to employers, managers, foremen and workers, but also to all who come into contact with our industrial system, as medical men, social workers, designers of factories, consulting engineers, teachers of engineering, magistrates and many others. If, as many believe, the chief problem before our country at the present time is the revision of its industrial methods, one thing at least is certain that the problem will be found to need for its solution, contributions from many quarters, and it is in the hope that the Industrial Museum and this volume which describes it, may make a contribution, if a modest one, in respect of one of the not least important aspects of the question, that I bring it to the notice both of industry and of the public.

W Joynson-Hicks

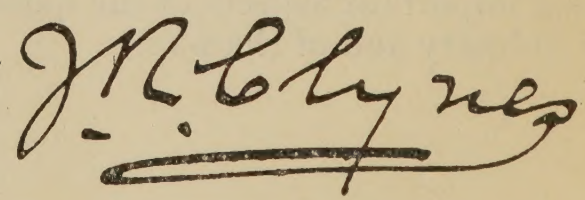
Home Office,
Whitehall.
7 March, 1928.

# FOREWORD TO SECOND EDITION.

By The Right Hon. J. R. Clynes, M.P.,

*Home Secretary.*

I am glad to have the opportunity of adding a few words by way of preface to the second edition of the Descriptive Account and Catalogue of the Home Office Industrial Museum. The fact that a second edition is called for within less than 18 months of its publication is good evidence that the Museum is serving a useful purpose. I can heartily endorse every word that my predecessor, now Lord Brentford, said in his Foreword to the First Edition last year. In the short space of time that has elapsed since its opening, the Museum has amply justified its existence. Its eminently practical character has specially impressed those who have visited it from the different industries. Many employers, managers and others have found in it answers to their own special problems and suggestions for new improvements. But if the Museum is to render to industry the full assistance of which it is capable, it needs the help of industry. Industry must use it and support it. The Museum is still unknown to great numbers and many even of those who have heard of it misapprehend its real character and purpose. I ask visitors to the Museum who find it helpful to spread the knowledge of what it is and what it can do for industry. The Museum also needs all the help it can obtain from industry in the way of suggestions and information as to new safety devices, new arrangements for health and welfare, and so on, which individual firms and others have experimented with; and I ask for the support of the industries in this matter also.



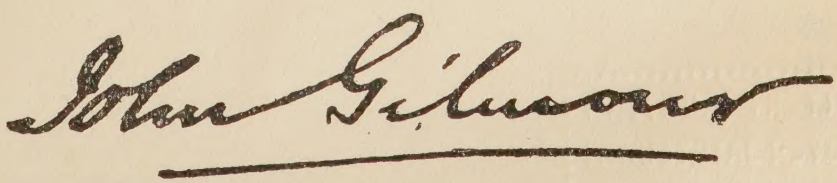
Home Office,
Whitehall.
29 August, 1929.

# FOREWORD TO THE THIRD EDITION.

By The Right Honourable Sir John Gilmour, Bart., D.S.O.,
*Home Secretary.*

I am glad that the appearance of a new edition of the catalogue of the Home Office Industrial Museum gives me an opportunity of testifying to the increasing value of the contribution made by the Museum to the safety, health and comfort of the industrial worker. During the six years which have elapsed since the opening of the Museum there has been a steady growth in its scope and in the services it renders. The exhibits have been kept constantly under review in the light of the fresh problems arising from modern industrial development and many additions have been made from time to time by the introduction of new or improved devices or methods ; and in order that this process may be continued and provision made for further expansion, an extension of the premises will shortly be undertaken.

It must be admitted, however, that the use made of the Museum by industry is still much too restricted and one of the chief problems in its management is how to bring the Museum more prominently and extensively before the industrial world. Much has been done through direct advertisement and other means of publicity, but for an institution of this kind personal experience affords the weightiest recommendation. I would therefore earnestly repeat the appeal of my predecessor, Mr. Clynes, and ask all those who have found a visit to be of value not to neglect any opportunity of bringing the services offered by the Museum to the notice of others who may also find it useful. I should like all engaged in industry to look upon themselves as partners with the Home Office in this enterprise and to regard its successful development and utilisation as a matter of immediate interest to themselves as well as to industry generally.



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# PART I.

## INTRODUCTION.

## GENERAL NOTE.

The Museum is a permanent exhibition of methods, arrangements and appliances for promoting the safety, health and welfare of industrial workers in the manufacturing industries and other industries which come within the sphere of Home Office administration. The establishment of the Museum was decided upon, and the building erected, before the War, but the War began before it could be opened. During the War and for some time afterwards it was used for military purposes. The restoration of the building to its pre-war condition and the organisation and collection of the exhibits were taken in hand in 1925; and the Museum was opened in December, 1927.

The exhibition is the first of its kind in this country, though similar exhibitions had existed previously in some important industrial countries on the Continent.

The purpose of the Museum is to show the best methods for the time being which are known to the Home Office for protecting the industrial worker against accidents, and promoting the conditions most favourable to his or her health and efficiency; and it is hoped that it will contribute in this way not only to the well-being of the workers, but also to the efficiency of British industry. It is an axiom accepted by all progressive employers that the best conditions are necessary to secure the highest standard of efficiency and the maximum output.

The Museum is open to the general public, but it is mainly intended for those who are directly concerned with the problems of safety, health and welfare in industry.

(*a*) Its main use is obviously for employers and workers and their organisations. It is designed to explain and illustrate the dangers to life and limb and health incidental to industrial processes, and to show the best methods of avoiding them. It is freely used by employers, works managers, foremen and workpeople who visit either individually or in parties organised by their associations, and also by the members of welfare departments and safety councils of factories.

(*b*) It renders important service to designers of factories, designers and makers of machinery and power plant, makers of guards for machinery and other protective appliances, and designers and makers of ventilation plant.

(*c*) Medical practitioners practising among workers who are liable owing to their occupation to contract one or other of the many industrial diseases, e.g., epitheliomatous ulceration, silicosis, lead poisoning, anthrax, dermatitis, etc., can find much information that is useful to them in the Health section of the Museum. The Silicosis and Asbestosis sections in particular contain a unique collection of skiagrams.

(*d*) For the Inspectors of Factories it serves as a centre of information on problems connected with their work. It has proved to be a valuable training centre for the newly-joined Inspectors. All Inspectors during their period of probation attend a course of lectures and demonstrations at the Museum given by the senior members of the staff. It is also the practice to have one of the Inspectors from the Divisions stationed at the Museum for a month at a time. This has proved valuable as a "refresher" course and has enabled them to spread the knowledge of what the Museum contains among the employers and workpeople in their districts.

(*e*) Many institutions and persons concerned with technical education make use of the opportunities afforded by the Museum to send their students to learn the principles of industrial safety. Visits to the Museum are included in the course of study of the Engineering Schools of certain Universities, Technical Schools and Trade Schools.

(*f*) The Museum serves as a centre to which improvements in appliances and methods for safety, health or welfare, find their way and by bringing together all that is best acts as a stimulus to further invention and improvement.

The Museum draws upon what is done not only in this country but also abroad. Conferences of the Directors of Industrial Museums from the chief industrial countries of Europe are held at intervals in different countries, and one was held in London in 1931 in connection with the Museum.

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The exhibits have been selected solely with an eye to their usefulness for the objects indicated. Every suggestion or offer received from inside or outside the Department has been tested by this standard. "Museum pieces" have been rigorously excluded.

I. In the "*Safety*" section of the Museum the exhibits consist chiefly of the actual machines, plant and appliances as they would be

installed in a factory or elsewhere. A few models are included, but models have been found by experience not to make the same appeal as the actual machine ; they are not the real thing. Power is provided so that the machines exhibited can be shown in actual movement, though in many cases it is not practicable to show the actual manufacturing process in operation. One section is devoted to electrical apparatus and includes types which do not comply with the Electricity Regulations and have caused fatal accidents, side by side with apparatus which shows how the requirements of the Regulations have been met.

These exhibits are supplemented by an extensive collection of photographs of actual installations in different parts of the country. This collection has a twofold object. The exhibits include necessarily only a small fraction of the many types of machinery, plant and appliances employed in the industries of the country, but by the use of photographs it has been possible to exhibit a much wider range of protective methods and appliances. For at least two important industries, viz., shipbuilding and the loading and unloading of ships at docks and wharves, the use of photographs is for the most part the only possible method of illustrating the dangers incident to the work and the precautions necessary.

Photographs of actual installations also serve to emphasise that the protective methods and appliances exhibited do not represent a standard of perfection which exists only in the mind of Factory Department officials and which the factory occupier or manager who has to carry on his business and get his work done cannot be expected to reach, but, on the contrary, that they are in actual operation in many works.

The photographs have either been taken by the official photographer of the Office of Works under the guidance of the Factory Inspectors and with the consent of the firms, or have been supplied by the firms themselves.

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II. In the "*Health*" sections of the exhibition, the exhibits are necessarily of a different character. The important section devoted to the chief *Industrial Diseases* includes photographs showing methods of preventing lead poisoning, silicosis, dermatitis, etc., in various industries, charts indicating the incidence of the diseases in various industries over a period of years, the " cautionary notices " issued by the Home Office for display in factories, models illustrating the lesions, etc., produced by the diseases, and microphotographs of lung sections, dust, etc. In the Anthrax section also will be found an interesting exhibit, prepared by the Director of the Home Office Anthrax Disinfecting Station at Liverpool, illustrating the disinfection process and comparing disinfected and undisinfected wools at various stages of manufacture.

One section is devoted to demonstrating the principles of efficient industrial *lighting*. This includes a darkened room in the basement divided into a number of cubicles in which the effects of colour, shadow, direct (specular) reflection, dirty fittings, glare, wall materials, and the effect of illumination on the rate of perception are shown.

Another section is devoted to illustrating the principles of efficient *heating and ventilation*. The ventilation section includes complete installations (connected with the grinding and woodworking machinery exhibits) for the removal of dust, demonstration illustrations of well and badly designed air ducts, and other ventilation arrangements, and photographs of actual installations from various industries. Devices for protecting the worker against dust and fumes are also installed in the pottery, wool sorting and aerographic exhibits on the ground floor. This section also includes a building specially designed and equipped for demonstrating the effects of atmospheric conditions in workrooms, and a plant which shows methods of preventing the dust generated in stone cutting processes from being inhaled by the worker.

III. The "*Welfare*" section of the exhibition includes rooms fitted up as an Ambulance Room, Rest Room, Canteen and Welfare Supervisor's Room, canteen equipment, types of work-seats designed to prevent fatigue and facilitate efficient work, types of First Aid boxes for factory use, many kinds of protective clothing, and photographs of welfare arrangements obtained from works covering a variety of industries.

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Full descriptive notices both for groups of exhibits and for the individual exhibits have been prepared. *Guards* and *protective appliances* on the machines are, where possible, *painted red* or *indicated by a red mark*.

The Museum shows not only what is best, but by contrast and by way of warning, *dangerous plant* and appliances which have been found in actual use—e.g., in the lifting gear section are dangerously worn ropes, chains, etc.; in the boiler section, parts from boilers which have exploded, showing the conditions which caused the accident; and elsewhere hand tools of unsuitable material and dangerous design.

The *building* itself, though of necessity primarily designed to serve the purposes of a Museum, has been arranged as far as possible to illustrate, in its own lay-out, matters such as ventilation, heating, lighting, fire escape, etc., which are of importance in the construction and equipment of factories.

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*Arrangement.*—The exhibition is divided into the following sections :—

*Ground Floor.*

Transmission Machinery.

Machine tools.
Power presses.
Textile machinery.
Bakehouse machinery.
Rubber incorporating rolls.
Aerographing cabinet.
Pottery processes.
Grinding machinery.
Woodworking machinery.
Hoist.
Boot and shoe machinery.
Printing machinery.
Sewing machines.
Boilers and other steam plant.
Laundry machinery.
Ladders.

*Gallery.*

Safety First.
Labour-saving appliances.
Weight Lifting.
Rescue and breathing apparatus and respirators.
Industrial diseases :—
- Anthrax.
- Lead poisoning and other diseases.
- Silicosis and Asbestosis.
- Dermatitis.

Welfare :—
- Seats.
- Supervision.
- Canteens.
- Ambulance and first aid.

Welfare (*continued*) :—
- Recreation.
- Works magazines.

Protective clothing.
Building.
Shipbuilding.
Docks (loading and unloading).
Rail lines (shunting, etc.).
Electricity.
Lifting gear.
Hand tools.
Goggles and eye screens.
Belt fasteners.
Explosions.
Fire.
Scientific apparatus.

*Basement.*

Principles and methods of ventilation.
Principles and methods of lighting.
Washing and sanitary accommodation.
Clothing accommodation.
Electric arc welding.
Noise insulation.
Lead Paint.

In the Basement are also situated the Lecture Room, the Museum Workshop, the Electrical Switch Room, the Boiler Room, and the Lavatories. In the Yard are the air conditioning and Stone Dressing buildings.

The development of Safety, Health and Welfare in the factories of the country has been continuous and is still continuing. There is no finality about it, and there can be no finality, therefore, in the exhibits shown in the Museum. Continuous efforts are needed to keep it up to date so that it shall at all times represent the "best practice" in industry and not degenerate into a "Museum of antiquities." In order to assist visitors, and especially those who are paying a return visit, to pick out the most recent additions, a *small blue label* is affixed to the last fifty exhibits and photographs added to the collection. This number represents a period of about six months at the present rate of increase.

The Home Office gratefully acknowledges the assistance which it has received in the establishment and upkeep of the Museum from many quarters—from numerous manufacturers who have given or lent most of the exhibits; from H.M. Office of Works; from the National Physical Laboratory; from associations including the Institution of Heating and Ventilating Engineers, and the Institute of Labour Management; and from other persons. The Museum needs the continuous support and co-operation of industry if it is to continue to render to industry the service which it is capable of rendering.

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A selection of Home Office publications relating to Industrial Safety, Health and Welfare, is on sale at the Museum.

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## THE BUILDING.

The building has necessarily been designed primarily to serve the purposes of a museum, but in its construction and equipment the opportunity has been taken as far as possible to illustrate matters which are of importance in the construction and equipment of factories.

Attention may be called to the following points.

*To face p. 6.*

GENERAL VIEW ALONG CENTRAL AISLE.

1. *Ventilation.*—The general ventilation of the building is effected by natural means, i.e., window openings and roof ventilators. The window openings are of large total area and well distributed in the walls and roof.

The general ventilation is supplemented in the Gallery by a number of fans of both oscillating and orbit types for producing movement in the air. Formerly a room was considered to be satisfactorily ventilated if the proportion of carbon dioxide in the air did not rise during occupation above a certain point. Physiologists now attach as much, or more, importance to air movement. Increased air movement means increase of body-cooling power and so adds to the efficiency and comfort of the workers. This insistence on the importance of air movement has led to increased use in factories of bench and other types of portable electric fans, wafters on shafting, etc. Experiments have shown that oscillating fans are efficacious in moving the air over wide areas without producing uncomfortable draughts. The fans have been lent by Messrs. Verity, The General Electric Co., Ltd., Revo Electric Co., Ltd., and Metropolitan Vickers, Ltd.

Special arrangements have been made for the ventilation of the Lecture Room in the Basement. An air conditioning and delivery plant has been installed in the adjoining room to provide an adequate supply of air, suitably washed and warmed, to the Lecture Room. A full description of the plant will be found in the adjoining room.

2. *Heating.*—The building is heated by a low pressure accelerated hot water installation consisting of a cast-iron sectional boiler and a circulating pump and motor. The heating units consist mainly of fixed radiators of various types placed under windows and well distributed throughout the building. Examples are also shown of the swing-out type of radiator—a type which facilitates cleaning, painting, etc., behind the radiator. In the Ambulance Room, what is known as the panel system of heating is shown. This system consists in the provision of extended surfaces heated to moderate temperatures. A better distribution of radiation can be effected by extended surfaces at a moderate temperature than by very small surfaces at higher temperatures. They are therefore suitable for warming large rooms and have the advantage that they are able to keep the occupants comfortably warm in relatively cool air or with relatively high velocities of air movement. It will be noticed that the front surface of the panel radiator shown is alone exposed so that it can very easily be kept clean.

3. *Lighting.*—Ample natural lighting is provided both by wall and roof windows.

Systems of artificial lighting both by gas and electricity are shown. The Gallery floor is lit mainly by gas ; the Ground floor and Basement mainly by electricity.

*Gas Lighting.*—The installation in the Gallery consists of thirty modern inverted gas lamps, each fitted with ten mantles on super-heated burners.

The reflecting shades are arranged with the lower parts opal and the upper parts in metal. The installation is divided into four sections, each controlled by a distant control valve.

Gas lighting has also been installed in the Basement corridor and Lecture Room to give an alternative method of lighting. The corridor installation consists of two special semi-indirect lamps with opal bowls and super-heated burner with three medium-size mantles. Each lamp is separately controlled by a switch fixed on wall.

The lamps have been lent by the Gas Light and Coke Company.

*Electric Lighting.*—The installation on the Ground floor consists of 52 " Reflector Refractor " fittings, each with a 300 watt gas-filled lamp, and five vitreous enamelled steel concentration reflectors, each with a 1,500 watt gas-filled lamp, hung from the lantern in the roof. The five reflectors in the lantern are fitted with gear by which they can be lowered to the Ground floor for cleaning.

The installation in the " Electrical Section " in the Gallery has similar " Reflector Refractor " fittings (four in number). The installation in the Basement consists of vitreous enamelled steel reflectors, viz. :—

In " Ventilation " Room and Arc Welding Room, " Britalux " fittings with 200 watt gas-filled lamps.

In Corridor, four " Britalux " fittings with 150 watt gas-filled lamps.

In Workshop and Electric Control Room, two " Geco " dispersive vitreous enamelled reflectors, with 150 watt and 300 watt gas-filled lamps respectively.

Reflector Refractor fittings *lent by* Holophane, Ltd.

Concentrating reflectors *lent by* The Benjamin Electric Co., Ltd.

Lowering gear *lent by* The London Electric Firm, Purley.

Dust-proof glass fittings *lent by* The General Electric Co., Ltd., London.

In the Rest Room in the Welfare Section (Gallery) is an installation of " Daylight " lighting.

In the case of both the gas and the electric installations, the arrangement of the fittings has been designed to give an illumination at the

working level of approximately 15 foot candles. This figure would be high as a standard of general lighting in a factory, but would be obtained in most works by the aid of individual lights over the working position of the machine.

4. *The Hoist or Lift* for passengers and goods has been installed so as to show the safety precautions required for prevention of accidents in connection with factory hoists or lifts. A full description will be found affixed to the hoist.

5. *Fire Escape.*—An outside fire escape of safe construction with fire exit doors (Gallery and Ground floor) indicated by the word "FIRE" in red letters, is provided.

Attention may also be called to the fire extinction arrangements installed at different points in the building. The hydrants ($2\frac{1}{2}$ in.) are fitted with a reducing adaptor which enables a hose of smaller diameter ($1\frac{1}{2}$ in.) to be used. A hose of this size is sufficient for most purposes, reduces water damage, is more manageable, and is less costly. The hose is fitted with "either end" couplings, a valuable device for facilitating connecting up in an emergency. The portable extinguishers provided are of the soda acid type.

6. *Safe means of access* to the roof and the motor room on the roof are provided by a properly designed spiral staircase, which has been given by The Carron Iron Co., Falkirk.

7. *Stairs.*—On the stairs are shown types of non-slip treads. Descriptions of these will be found by the stairs.

8. *Cleaning.*—A vacuum cleaning plant provided by The British Vacuum Cleaner Co., has been installed. Piping is installed throughout the building with six cleaning points on the Gallery floor and Ground floor and seven in the Basement. Armoured flexible hose is connected to any of the cleaning points with suitable tools for bare floors, carpeted floors, or wall cleaning. The vacuum cleaner set is operated by a remote control system (lent by Brookhirst Switchgear Ltd., London), which enables the machine to be started or stopped from any floor.

9. *Lecture Room.*—As a cinematograph lantern is to be used from time to time in this room, an alternative exit in case of fire has been provided in the room adjoining, by means of casement windows opening outwards. The windows are operated by the Standard Emergency Push Bar Lock.

A fire resisting door, given by Mather and Platt, Ltd., has been installed.

PART II.

SAFETY.

*GROUND FLOOR.*

# TRANSMISSION MACHINERY.

## General.

Transmission machinery (or mill-gearing, as it is called in the Factory Act, 1901) includes every appliance which serves as a connecting link for transmitting the power from a prime mover to a machine, but not the gear wheels, belts and pulleys, etc., of the machine itself which transmit the power received by it to its moving parts.

The transmission machinery in a factory may be placed overhead or near the floor level or under the floor, and may range from a short length of shafting and a few belts and pulleys to hundreds of yards of shafting with hundreds of pulleys and belts and other transmission details.

Transmission machinery is responsible each year for a heavy toll of accidents. During the six years 1927–1932, the accidents have numbered 247 fatal and 7,245 non-fatal. A comparison with the six-year period 1907–12, for which the total was 421 fatal and 10,536 non-fatal, shows appreciable reduction, which may be attributed in part to the steady improvement in safeguarding standards.

Many of these accidents are of the most serious kind and are caused by the workers coming into contact with the revolving shafting or other moving part of the transmission machinery while engaged in oiling bearings, adjusting belts, cleaning shafting, lime-washing ceilings, executing repairs or performing other occasional work in the vicinity.

The danger of revolving shafting cannot be over-estimated. If loose clothing, e.g., an apron, a coat end, a wide or ragged sleeve, or a rag in the hand of a cleaner comes into contact with the shaft, it may wrap round the shaft in a moment, and before the wearer is aware of what is happening, he may be caught, whirled round, and killed or terribly injured. Such accidents can and do occur even with smooth shafting: the contrary view, often expressed, is contradicted by experience.

Accidents are also caused by clothing catching in projecting bolt heads, nuts or screws on collars and couplings and heads or ends of keys.

Moving belts are also responsible for many accidents. Sometimes the worker is caught and carried round the shaft, but more frequently the accident is caused by the worker being struck by a projecting belt fastener, or trapped at the point of intake of the belt with the pulley.

Every part of the transmission machinery is a potential cause of accidents and is required by the Factory Act to be securely fenced or to be in such position or of such construction as to be equally safe.

Fencing should therefore be provided for—

(i) low shafting and mountings thereon ;

(ii) belts up to a certain height ;

(iii) as a rule, fast and loose pulleys on the machine to which the power is transmitted ;

(iv) belts, ropes or chains running above gangways or working positions, which may cause injury to persons underneath in the event of breakage.

A different question arises with regard to transmission machinery which is out of reach from the floor. If it can be, and is, approached, e.g., by persons engaged on oiling bearings, mounting belts, lime-washing or painting walls, or other occupations, the requirement as to fencing applies. The expense, inconvenience and difficulty, however, of providing and maintaining fencing for the whole of the overhead plant are such that in many cases alternative arrangements to ensure that the machinery shall not be approached while in motion, have to be considered. These include (1) the stopping of the machinery while the work is being done, or running it dead slow (this can be facilitated by sectionalising the machinery) ; (2) the adoption of appliances for replacing belts, lubrication, etc.

There are great advantages in sectionalising the machinery, and it is common in modern factories. It enables the machinery to be stopped in sections for oiling, belt mounting or work near the shafting in processes where it would be impracticable or inconvenient to stop the whole of the machinery, e.g., where the processes carried on are continuous and loss or damage would be caused by stopping them ; and it often effects economies in working, e.g., where overtime or a night shift is worked with part only of the plant.

Sectionalising is most complete where each machine is driven by a separate motor. Where the machines are driven from shafting, sectionalising may be effected either by having the shafting divided into short lengths each driven by a single motor, or by installing friction

clutches at suitable positions on the line shafting. Such clutches are very convenient appliances, capable of being engaged or disengaged in any position, either when at rest or in motion, and of gradually and smoothly starting up the load from rest to full speed, and of driving without slipping. Friction clutches at intermediate points in a line of shafting take the form of shaft couplings : at the power-receiving end of a belt-driven shaft, a clutch pulley is used.

Other safeguards are—

(i) the provision of belt perches in order to prevent dismounted belts riding on the shaft ;

(ii) elimination as far as possible of all projections, which are liable to catch in clothing, such as bolt heads, nuts, screws on flange and other types of couplings, set screws on shaft collars, key heads at couplings, wheels and pulleys ;

(iii) use of modern types of bearings requiring attention only at long intervals ;

(iv) safe types of belt fastenings.

---

The transmission machinery which has been installed in the Museum for running the machines exhibited illustrates the various ways of safeguarding such machinery.

Low shafting is boxed in or protected by a sheet metal covering (in shape of inverted U) or by loose metal sleeves (Woodworking Exhibit) or otherwise fenced (Sewing Machines).

Protection of overhead shafting by loose sleeves (mill-board) and other fencing is shown.

Belts over gangways are protected by stout wire mesh guards and belts between the shafting and the machines by similar guards to a height of 6 ft. 6 in. from the floor, such guards protecting also the low machine pulleys.

Bolts fastening couplings (on overhead shafting), screws, etc., are recessed or shrouded.

The shafting is " sectionalised " and electrical devices for stopping immediately in an emergency and for " inching " the shafting are provided.

Types of belt poles and belt mounters for replacing belts, belt-shifter for stepped cone pulleys, belt perches, and " remote control " methods of lubrication are shown.

Detailed descriptions of the various arrangements are given in the descriptive notices displayed in the Museum.

*References.*

(*a*) Report on Fencing and Safety Precautions for Transmission Machinery (1913) : (*b*) Home Office Safety Pamphlets, Nos. 1 and 12. Published by H.M. Stationery Office.

*Sleeve or Tubular Guards.*

Metal.

*Lent by* GEORGE TAYLOR (BRASSFOUNDERS), Ltd., Bolton.

*Lent by* HAMILTON (ROCHDALE), Ltd., Cheetham St., Rochdale.

Millboard.

*Lent by* HUGH STEVENSON, Ltd., Manchester.

*Friction Clutches.*

The " Edmeston."

*Lent by* ARCHIBALD EDMESTON & SONS, Ltd., Manchester.

The " Atlas."

*Lent by* R. HUNT & SON, Ltd., Earls Colne, Essex.

The " Suregrip."

*Lent by* FRANK WIGGLESWORTH & Co., Ltd., Shipley.

The Benn Patent Friction Clutch.

*Lent by* THE UNBREAKABLE PULLEY & MILLGEARING Co., Ltd., Boundary St., West Gorton, Manchester.

*Emergency Stop.*

*Lent by* BROOKHIRST SWITCHGEAR Ltd., London.

## Lubrication.

Oiling or greasing of unfenced transmission machinery in motion has been the cause of many accidents. Even when the machinery is fenced there is risk in oiling or greasing bearings unless the fencing completely encloses the adjacent moving parts.

Of 123 fatal accidents which were caused by shafting during a period of three years, twenty-four happened to workmen when oiling bearings, pulleys or clutches, and of 754 non-fatal accidents during the same period, 101.

Transmission machinery, which is not fenced in a manner to afford complete protection, must not be approached for the purpose of looking to the lubrication while the machinery is running. If lubrication has to be attended to while work is going on, the part must be stopped or slowed down, or " remote control " methods of lubrication must be employed.

Two systems of lubricating ordinary journal bearings without approaching the machinery are shown. One method is to provide a long

pole or tube by means of which the operator can supply the lubricant to an overhead bearing from the ground. One exhibit illustrating this is a long pole fitted with a device by means of which the oil bottle can be removed from the bearing, lowered, refilled and replaced. Another is a portable force pump connected to a rigid tube with a flexible end terminating in a device which the operator can, from the ground, fit over the lubrication inlet of the overhead bearing. The other method exhibited is an arrangement by which the bearings are supplied automatically with oil by pipes from a reservoir under pressure, which is placed in a position where it can be kept under observation. (*See* descriptive notices.)

*Lent by—*

Mr. W. SCHOFIELD, 16, Fairbank Terrace, Manningham, Bradford.
TECALEMIT, Ltd., Scrubbs Lane, London, N.W.
SOUTH METROPOLITAN GAS Co., London, S.E.

The amount of oiling required to be done, and therefore the inconvenience and delays involved, can be greatly reduced by installing self-lubricating or " anti-friction " types of bearing, e.g., ring, roller or ball. These require attention at long intervals only, the supply of lubricant with some types lasting for months. Examples are installed in the Museum (*see* descriptive notices).

*Exhibits lent by—*

THE HOFFMANN MANUFACTURING Co., Ltd., 8, Bedford Square, W.C.1.
RANSOME AND MARLES BEARING Co., Newark-on-Trent, and 17, Victoria St., London.
SKEFKO BALLBEARING Co., London, W.C.2.
R. HUNT AND SON, Ltd., Earls Colne, Essex.
F. WIGGLESWORTH, Ltd., Shipley, Yorks.

Whatever precautions are taken, it is essential that precise instructions should be laid down and strictly enforced by the management as to the persons by whom, and the manner in which and times at which, oiling or greasing of transmission machinery is to be done. Only trained and authorised persons should be allowed to attend to it.

## Fencing of Overhead Belts above Gangways or Work Places.

Breakage of overhead belts when running has caused serious and even fatal accidents to persons working or passing beneath, and the greater the weight and speed of the belt, the greater the danger. Trough guards suspended underneath the belts afford protection against this risk. Such guards should be strongly constructed, supported and secured—otherwise breakage of the belt might wreck the guard and intensify the danger.

The guards may be suspended either from the ceiling or from the shaft, split collars of special design being provided as supports. Both arrangements are exhibited.

*Lent by—*

(1) F. W. POTTER & SOAR, Ltd., London.
(2) FREDK. BRABY & Co., Ltd., Deptford.
(3) PROCTOR Bros., Ltd., Leeds.
(4) E. C. TWEED & Co., London.
(5) JOHNSON CLAPHAM & MORRIS, Ltd., Manchester.

Overhead driving chains require protection for the same reason.

*Overhead Chain Drive, with fencing installed by*—COVENTRY CHAIN Co., Ltd., Coventry.

## Belt Mounting.

Of the 123 fatal accidents which were caused by shafting during a period of three years, thirty-one happened to workers attempting to replace belts on pulleys by hand, and of 754 non-fatal accidents during the same period, 215 were due to this bad practice.

There are only two safe ways of replacing dismounted belts while work is going on. Either, the machinery should be stopped or run dead slow, but this entails inconvenience and delay where the shafting or section of shafting involved operates a number of machines. Or, means for replacing the belt should be used which can be operated from the floor. These include (*a*) belt poles, and (*b*) belt mounters fixed beside the driving pulleys. Examples of both are exhibited.

Fencing of the machinery is not by itself sufficient protection, as, even were the shafting completely enclosed and the sides of the pulleys filled in, the danger from handling the belt at the moving pulley rim would remain.

*Belt Poles.*—Where the shafting is not too high (say not more than 10 to 12 ft. from the floor) belts both vertical and inclined, if of moderate dimensions, can generally be replaced by means of a belt pole, so avoiding the necessity of stopping the machinery. This operation is made much easier if suitable belt perches are provided (*see* below).

The pole is the cheapest form of belt mounter and is especially serviceable in rooms where a large number of similar machines are installed, e.g., looms in weaving sheds.

The commonest type of belt pole is a strong straight and light pole, with or without an iron mounting pin fitted near the end. The pin is slightly tapered to make it easier to disengage from between the pulley and the belt.

Belt poles with a flexible extension to carry the pin are even more serviceable—the flexible end bending as the moving pulley takes up the belt and carries it forward, and so enabling the belt to be held in contact with the pulley until it is mounted. Two types of such poles are shown.

Mounting a belt with a pole requires some strength, skill and judgment, and should only be done by persons experienced in its use. Belt poles should not be employed where the shafts are very high, or where the belts are specially tight, or where the available standing positions are unsatisfactory for their manipulation.

*Flexible Pole lent by*—O. N. BECK, Queen Victoria Street, London, E.C.

*Small " Belt Poles " lent by*—
MENTMORE MANUFACTURING Co., Ltd., Tudor Grove, E.9.
LONDON ELECTRIC WIRE Co. & SMITHS, London.

*Belt Mounters.*—With these the belt is moved by a mechanical contrivance operated from the floor. Several examples are exhibited : for description of their construction, *see* the notices.

*Lent by*—
FRANK WIGGLESWORTH & Co., Ltd., Shipley, Yorks.
J. BROUGHTON, Vere Street, Birmingham (2 examples).
GEORGE SAXON, Ltd., Manchester.
BAMAG-MEGUIN (Great Britain) Ltd., Broadway Buildings, London, S.W.1 (for stepped cone pulleys at milling machine).

## Belt Hooks, Hangers or Perches for Dismounted Belts.

A belt dismounted from its pulley should not be allowed to " ride " or hang loosely on the revolving shaft, as in that position it is liable to grip the shaft and, if it catches a worker, to draw him up to the shaft. Occasionally, too, a dismounted belt will move laterally along the shaft and become entangled in a machine, with serious consequences. These accidents are avoidable and should not be allowed to occur. The belt is sometimes tied in a knot and left suspended on the shaft, or tied up overhead clear of the shaft to a fixture, but both these practices involve risk of accident.

The risk is eliminated by providing an efficient belt hook, hanger or perch beside the driving pulley to act as a support for the dismounted belt. Various types of these are shown in position. (*See* descriptive notices.) A provision of this kind is still more important in cases where belts are specially liable to be dismounted accidentally, e.g., belts working on pulleys not set in the same plane, as at quarter or half twist drives.

*Simple Perches.*—
(*a*) Hook perch.
(*b*) Shaft sleeve (on each side of pulley) serving as perch.

Some perches are so shaped as to make it easy to replace the belt on the pulley with the aid of a pole or stick; several types of these are shown.

*Mounter Perches.*—

(*a*) " Biedermann " or multiple peg type.

(*b*) and (*c*) Concentric block perches aligned with pulley rim, one for vertical and one for inclined belt.

Belt perches must be strongly constructed and securely and rigidly bolted to ceiling, beam, or other fixture, and so installed in relation to the pulley that the dismounted belt cannot be caught between perch and pulley.

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## Belt Fasteners.

An exhibit of types of belt-fastenings is shown in the Gallery (Case Y).

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## PHOTOGRAPHS.

Adequate methods of fencing transmission machinery and prime movers adopted in various works are shown on Screen IV.

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*GROUND FLOOR—LEFT OF ENTRANCE.*

## MACHINE TOOLS.

Machine tools are responsible for over 6,000 accidents a year. Many of these are due to the absence of efficient guards on dangerous parts such as toothed gears, chain gears, belts and pulleys. In recent years many machine-tool makers have designed their machines so as to avoid

the exposure of dangerous parts, e.g., by the complete enclosure of gear wheels ; this has been found advantageous in reducing wear and damage, as well as preventing accidents.

Flying particles or chips of metal from the material being worked are a common source of accident to the eyes, especially on lathes. An adjustable screen of transparent material (e.g., celluloid, triplex glass, etc.) placed between the face of the worker and the work will prevent these ; such screens, of which a specimen is shown, are being increasingly used.

The term " machine tools " covers a very wide variety of machines ranging from a small sensitive drill to a heavy gun lathe or a massive machine for planing large castings. In the space available, it is only possible to exhibit some of the most common types of machine tools, such as drilling machines, lathes and milling machines.

## Turret Lathe.

Modern type of hexagon turret lathe used for the accurate turning (out of metal bars) of various parts of machines, engines, etc., especially when such parts are required in large quantities.

This type of lathe is driven by a single pulley and belt, thus dispensing with a countershaft and cone pulleys with their attendant risks. The lathe can be started, stopped or reversed by lever, and speed changes are effected by levers operating friction clutches connected to gears enclosed in the head. The levers are automatically interlocked to prevent the engagement of two sets of gears at the same time.

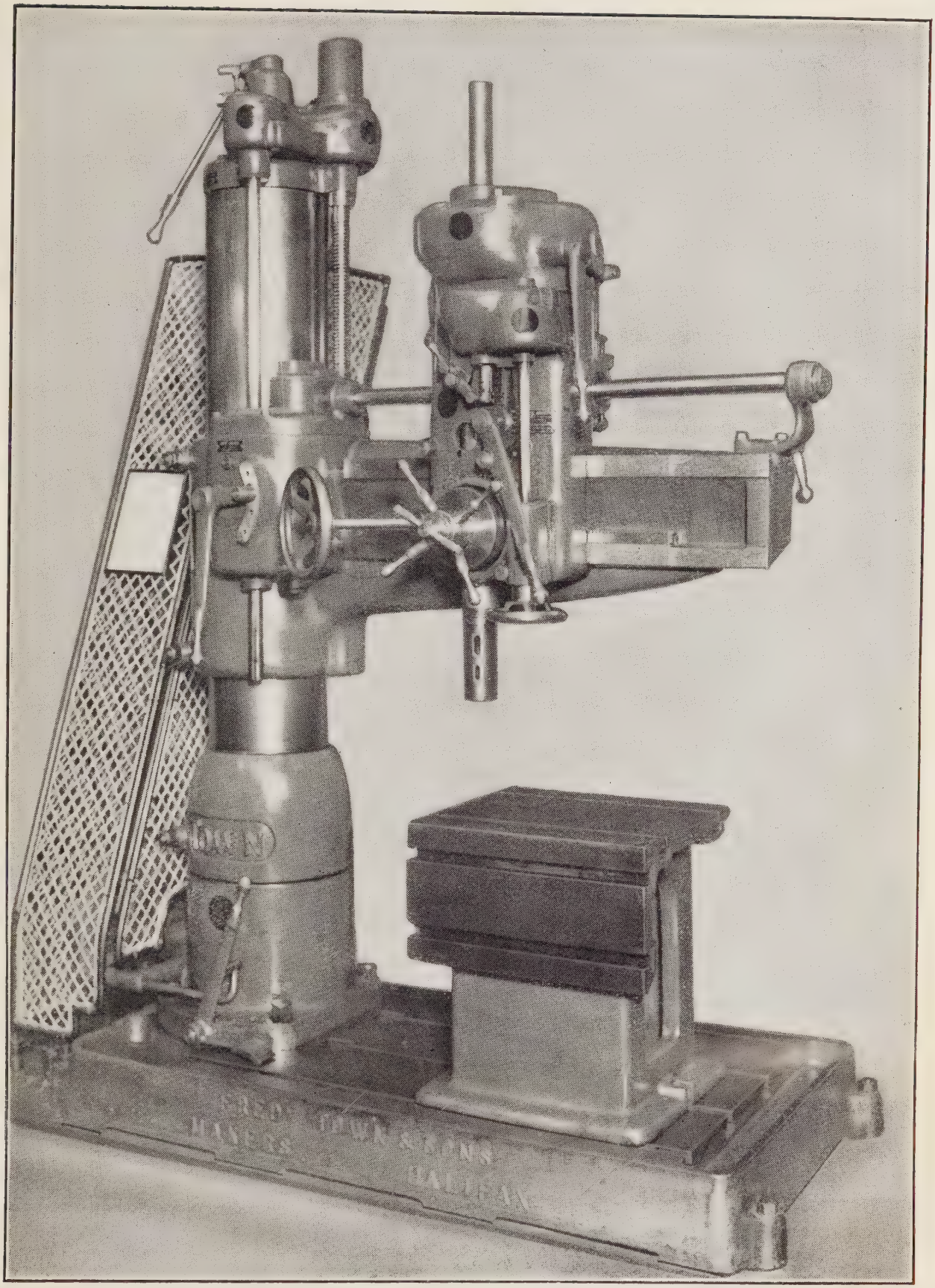
The special safety features of this exhibit are :—(1) Guard for intake of driving pulley and belt ; (2) all gear wheels completely enclosed ; (3) chain belts for quick traverse and feed motions completely enclosed ; (4) revolving stock bar covered with two hinged metal guards ; (5) double toggle chuck fitted with metal cover ; (6) pilot wheel on turret slide does not rotate when the feed or quick traverse motions are in operation.

*Lent by*—ALFRED HERBERT, Ltd., Coventry.

## Radial Drilling Machines (2).

1. An old type of machine constructed before machine-tool makers devoted attention to the provision of guards for dangerous parts. Changes of speed both for the drill spindle and feed motion are effected by cone pulleys and belts, which are liable to give rise to accidents, as the belts are often moved by hand from pulley to pulley. Contrast with this the arrangements in the modern radial drilling machine adjoining. Other points of danger are (1) the various toothed gears which, in the exhibit,

*To face p. 18.*



MACHINE TOOL SECTION.

Radial Drilling Machine, designed with all gears covered.

are fenced by means of sheet-metal guards or wire-mesh screens ; and (2) the driving belt and pulleys which are safeguarded by means of a strong wire-mesh screen, 6 ft. 6 in. in height.

2. A modern type of machine in general use in engineering works for drilling and tapping holes in metal parts.

The machine is driven by a belt with fast and loose pulleys on the machine shaft. The pulleys and belt should be fenced as in the exhibit by means of a strong wire-mesh screen of adequate height. Changes of speed for the various parts are effected by means of sets of gear wheels ; these are completely enclosed with cast-iron guards which have been designed with, and form an integral part of, the machine. A foot-controlled emergency stop is also fitted.

*Lent by*—FREDK. TOWN & SONS, Mile Cross Engineering Works, Halifax.

## Milling Machines (2).

1. An old type of small horizontal milling machine generally operated by a woman or young person and used for cutting slots, keyways or recesses in small metal parts of machines, etc.

The principal danger on this machine arises from the risk of the operator's hand or arm coming into contact with the revolving toothed cutter, resulting usually in the loss of part of the hand or arm. The danger can be obviated by shrouding the cutter with a suitable metal guard which is perforated to permit the use of the cutting lubricant. Several types of guards are shown and these are described in separate notices.

Other points of danger are the cone pulleys and belts for effecting changes of speed of the cutter-spindle and feed motions, whereas on more modern types of this machine speed changes are effected by gears which are completely enclosed. On this machine the belt is shifted on the cone pulleys by means of the " Bamag " mounter.

Accidents sometimes arise through the operator's clothing catching on the inclined feed motion shaft with universal joints ; and in the exhibit a telescopic metal guard has been fitted over this.

On the machine exhibited, the handles for moving the vertical table and cross slide are badly situated as the operator's hand on one handle is liable to be struck by the other when used.

*Guards lent by*—
J. BROUGHTON, Birmingham.
BRAYSHAW FURNACES & TOOLS, Ltd., Manchester.
RANSOMES, SIMS & JEFFERIES, Ltd., Ipswich.
NORTHERN COMPONENT & MAINTENANCE Co., London, N.W.
EDWARD WILLIAMS & Co., Foundry Lane, Birmingham.
GESTETNER, Ltd., Tottenham, London, N.

2. A modern type of vertical milling machine in which many safety features are incorporated in the design of the machine. The main driving belt and pulleys and also the chain drive for the traversing gears are enclosed in a strong casing provided with a detachable plate. The change gears are housed in a chamber which serves as an oil bath and all bevel wheels are securely fenced. A feature is the safety stopping and starting lever of the dead centre type. The convenient positions of the control handwheels should be contrasted with those on machine No. 1.

*Lent by*—ALFRED HERBERT, Ltd., Coventry.

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## PHOTOGRAPHS.

Different methods of fencing milling machine cutters are shown on Screen VI.

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On Screen V are shown modes of fencing various classes of machines.

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## POWER PRESSES.

The dies or tools of power presses have long been recognised as dangerous. Accidents are generally severe and usually result in permanent mutilation of the hands. Much thought and ingenuity have been devoted to the problem of protecting the operators. The problem has been rendered more difficult by the great variety in the materials dealt with and the many different operations performed.

It is probable that power presses are more commonly used in the light metal trades than in any other industry; hence the question of fencing the dies of power presses used for light metal work has, so far, received the greater attention, but it has been found that guards devised for metal work are often suitable for power presses used on articles other than metal.

Broadly speaking, guards for power presses may be divided into two distinct classes, viz. :—(1) Fixed guards ; and (2) automatic guards, and the selection of the class of guard to be used is, in the main, determined by the method of feeding the article into the dies of the machine. In this exhibit different types of guards in both classes are shown, but these should be regarded only as typical examples of each class, since it is not possible to exhibit every variation of type found in actual use. The guards shown are in general use by many firms of wide experience.

Accidents are also liable to occur after the guard is removed in order to allow the tool-setter to change or set the tools. The provision of a safety catch which will prevent the clutch operating while the tool-setter is at work is very desirable.

*Accidents on Power Presses in the Metal Trades.*

| *Year.* | *Number of Reported Accidents.* Deaths. | *Disablement.* |
|---|---|---|
| 1925 .. .. .. .. | — | 609 |
| 1926 .. .. .. .. | 1 | 479 |
| 1927 .. .. .. .. | — | 492 |
| 1928 .. .. .. .. | 1 | 487 |
| 1929 .. .. .. .. | — | 564 |
| 1930 .. .. .. .. | 1 | 433 |
| 1931 .. .. .. .. | — | 379 |
| 1932 .. .. .. .. | — | 464 |
| | — | — |
| Total for 8 years .. | 3 | 3,907 |
| | — | — |

*Reference.*

Home Office Safety Pamphlet No. 9, " Fencing and other Safety Precautions for Power Presses," published by H.M. Stationery Office, price 1*s.* 6*d.*

## Machine No. 1.

Where a large number of small articles have to undergo the same process, the operation can be performed on a machine fitted with a dial feed so arranged that the work can be fed into and taken from the lower die without the hand coming near the upper die. The danger zone is protected by a fixed guard (through which the work can be viewed if and when required) so that the operator cannot inadvertently place his hand in danger. With this type of feed a quick operator can keep the machine supplied at its maximum speed, thus ensuring maximum output without risk of accident. A safety catch is fitted to the clutch plate, and a protector over the pedal. The object of this protector is to afford, in some measure, a rest

for the operator's foot by means of the horizontal bar across the protector. The bar must be properly placed in relation to the pedal, in order to enable him to operate the machine. A guard of this nature can only be used on pedals having a short travel.

*Machine and dial feed lent by*—TAYLOR & CHALLEN, Ltd., Derwent Works, Birmingham.

*Guard to dies lent by*—J. BROUGHTON, Vere Street, Birmingham.

*Pedal protector lent by*—THE BENJAMIN ELECTRIC Co., Ltd., Brantwood Works, Tariff Road, N.17.

## Machine No. 2.

The " feeding " of this machine is entirely automatic. The metal strip to be operated on is coiled on a stand at one side of the machine and is passed between the dies by means of two pairs of rolls (one at each side of the machine table) ; the " feed " being regulated mechanically as required. A fixed guard is fitted which prevents accidental access to the tools, while allowing the operator a full view of the work in progress. A safety catch is fitted to the clutch plate.

*Machine and roll-feed mechanism lent by*—TAYLOR & CHALLEN, Ltd., Derwent Works, Birmingham.

*Guard to dies lent by*—J. BROUGHTON, Vere Street, Birmingham.

## Machine No. 3.

With many classes of work the article to be operated on has first to be placed by hand in an accurate position on the lower die ; the plunger or ram is then set in motion by the depression of the foot pedal, after which the finished article must be removed by hand if it is not mechanically ejected. Many serious accidents have occurred when the work was being (*a*) fed-in, or (*b*) taken out, through the top tool descending before the operator's hand was clear of the dies. Guards which are mechanically operated either by the crank shaft or the ram of the press and which automatically remove the hand from the space between the dies when the latter close from any cause, are now in common use. A link motion guard of the back-to-front type is shown on this exhibit. The guard may also be locked in the vertical position and used as a fixed guard for strip feeding. Safety catches are fitted to the clutch plate and foot pedal.

*Machine lent by*—BRADLEY & TURTON, Ltd., Kidderminster.

*Guard to dies lent by*—J. P. UDAL, B.Sc., 45, Upper Dean Street, Birmingham.

## Machine No. 4.

Blanking or cutting out operations on strips or sheets of metal can be carried on in safety by passing the metal strip or sheet to the dies through a suitable opening in a guard fixed around the dies. There are many

kinds of these " fixed " guards in actual use, some examples of which are shown. The false table fitted around and level with the lower die is an additional safeguard which assists production. A safety catch is fitted to the clutch plate.

*Guard to dies lent by—*
SMITH METERS, Ltd., 186, Kennington Park Road, S.E.11.
*Extra guard made by—*
COVENTRY RADIATOR & PRESSWORK Co., Ltd., Raglan St., Coventry.

## Machine No. 5.

*See* note on Machine No. 3.

A positively operated guard of the side-to-side type is shown. It is directly connected to the crank-shaft of the press and makes one complete journey to and fro across the feed opening for each revolution of the crank-shaft. The sliding member of the guard is timed in advance of the descending ram, so that the hand is pushed clear of the dies before the latter close. The side screens prevent access to the danger zone at the sides of the dies.

Other guards of the side-to-side type, which are operated by either the crank-shaft or the ram of the press and which automatically remove the hand from the danger zone on the descent of the plunger, are exhibited with this machine. A safety catch is fitted to the clutch plate.

*Machine lent by*—TAYLOR & CHALLEN, Ltd., Derwent Works, Birmingham.
*Guards to dies lent by—*
J. BROUGHTON, Vere Street, Birmingham.
GILBERT PRODUCTIONS, Ltd., Hay Mills, Birmingham.
HORDERN MASON & EDWARDS, Ltd., Vesey Street, Birmingham.

## Machine No. 6.

*See* note on Machine No. 3.

A guard of the back to front type is shown. The guard is driven from the crank-shaft and so is positive in its action ; also should the press " repeat," the mechanism automatically brings the swinging member of the guard into action.

The centre portion of the guard is always in operation, but should the operator by chance leave his hand within the machine after depressing the pedal, both the inner and the outer frames move forward and so take his hand out of the danger zone. The lower bars between which the operator's hand is held and pushed out of the danger zone, are rubber-covered to reduce the force of the " blow."

The finished work is discharged at the back of the press and the metal " shoot " directs it into a suitable receptacle. The " shoot " also forms a guard for the back of the machine.

A guard over the pedal, as shown, prevents the accidental starting of the press.

*Guard to dies lent by*—J. P. UDAL, B.Sc., 45, Upper Dean Street, Birmingham.

## Machine No. 7.

This machine illustrates the advantages of a guard of the back-to-front type on wide power presses, for sweeping the operator's hands clear of the dies before they become dangerously close.

Moreover where (as often happens on large presses) the work is taken off by hand at the back of the machine, there is the risk of the hands of the operator who is taking off being caught in the dies. Another guard of the back-to-front type is therefore fitted at the back. A safety catch is fitted to the clutch plate.

A cover is fitted over the foot pedal to prevent accidental depression of the pedal.

*Machine lent by*—TAYLOR & CHALLEN, Ltd., Derwent Works, Birmingham.

*Guards lent by*—

J. P. UDAL, B.Sc., 45, Upper Dean Street, Birmingham (front guard).

J. BROUGHTON, Vere Street, Birmingham (back guard).

## Punching Machine Guard.

*Lent by*—H. O. STRONG & SONS, Ltd., St. Paul's, Bristol.

## Self Righting Cutters.

*Lent by*—BRITISH UNITED SHOE MACHINERY Co., Ltd., Leicester.

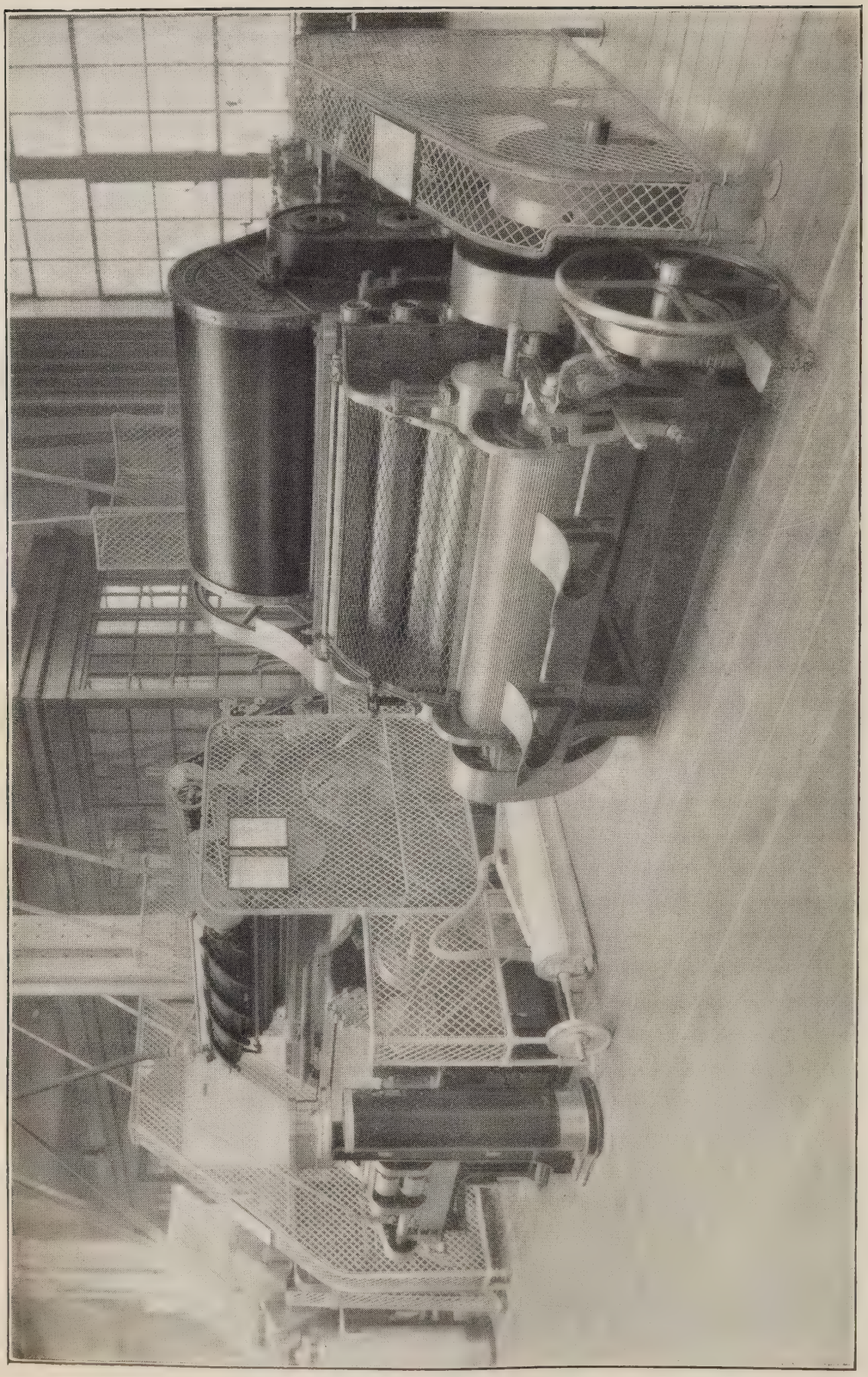
## Metal Cutting Guillotine.

Many accidents occur even on the treadle-operated guillotine (with the power-operated machines the accidents are higher) owing to the operator pressing the pedal before his fingers are away from the knife.

This machine has a fixed guard inclined at a suitable angle to the knife or blade, so as not to obscure the cutting lines on the metal sheet. The guard is so fixed that the metal sheet will pass under it, but there is no room for the operator to get his fingers either under or over the guard. Similar guards can be fitted to power-driven machines.

*Lent by*—J. RHODES & SON, Ltd., Wakefield.

*To face p. 25.*



TEXTILE SECTION.

Scutcher (right). Carding Engine, with interlocking cover open (left); on floor at side, exhaust attachment for stripping.

## PHOTOGRAPHS.

Methods of guarding buffer presses, brick presses, and metal-cutting guillotine are shown on the adjacent window screen.

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## TEXTILE MACHINERY.

The cotton and woollen industries are important, from the point of view of risk of accident, owing to the complexity of the machinery and the nature of the processes ; and the work of safeguarding the machinery has by regulation and a series of agreements reached at conferences between the Home Office and the representatives of manufacturers and workers in the industries (1911 to 1928) been carried further perhaps than in any other industry. An analysis of the accident figures for 1924 in comparison with those for 1913 showed that, after making allowances for the reduction in the hours of work and other factors, certain types of accidents of the more serious kind on the principal classes of cotton machines have as a result of the measures adopted been substantially reduced and in some cases eliminated. (*See* Annual Report of Chief Inspector of Factories for 1924, pages 19–20.)

The exhibit includes types of the following machines :—

| | |
|---|---|
| Scutcher .. .. .. .. | Cotton spinning. |
| Carding Engine .. .. .. | |
| Drawing Frame .. .. .. | |
| Slubbing Frame .. .. .. | |
| Spinning Frame .. .. .. | Worsted. |
| Loom .. .. .. .. .. | Wool and Worsted |

A wool-sorting " screen," and a truck for transporting the heavy loom " beams," with a lifting arrangement for placing them in the loom, are also shown.

Apart from points of interest peculiar to textile machinery (as to which *see* separate description for each machine), the exhibit illustrates a number of points which are of general importance, as follows :—

| | |
|---|---|
| Pulleys.. .. .. | " Plated " instead of spoked. |
| Shafts .. .. .. | Protected by sleeve guards. |
| Cog wheels .. .. | (*a*) Completely enclosed. |
| | (*b*) Protected by hinged guards, covers or doors so interlocked that they cannot be opened whilst the machine is in motion by power, and the machine cannot be started until the cover is closed and locked. |
| Set screws .. .. | Covered or counter-sunk. |
| Dust removed at or near point of origin by application of the " Vacuum cleaner " principle, or by other exhaust ventilation | |

*References.*

Home Office Safety Pamphlets—Nos. 4, 5 and 6—" Safety Precautions for Cotton Spinning and Weaving." Home Office Reports on Conferences between Employers, Operatives and Inspectors on the Fencing of Machinery, etc., in (*a*) Cotton Spinning, (*b*) Cotton Weaving, (*c*) Woollen and Worsted Spinning and Weaving. Dust in Cotton Card Rooms—Report of Departmental Committee, 1932. Published by H.M. Stationery Office, Kingsway, W.C.2.

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## COTTON SPINNING MACHINERY.

### The Scutcher.

Used in the preliminary processes of opening the cotton and removing dirt, seed and husk.

The matted cotton is carried by a lattice feed (not shown) to the small-diameter feed rollers which hold it while the beater tears the cotton away in small tufts, the heavier foreign matter dropping through the grid (not shown) below the beater. The cotton is collected by fan suction in the form of a sheet on a pair of cylindrical cages (the top one only shown) from which it passes through the calender rollers and is wound round the lap roller preparatory to carding.

*The Beater.*—Many serious accidents, even to experienced operatives, have been caused by fingers, hands, and arms being caught between the beater and the fixed knife at the back of the beater when the worker has opened the glass door known as the " desk plate door " after the driving belt has been shifted to the loose pulley, but before the beater had fully come to rest, and put in his hand to feel for a possible obstruction.

There are several devices by which these accidents can be prevented. One is shown on the machine which ensures that the door over the dirt grid and also the cover over the beater cannot be opened whilst the beater is in motion and that the beater cannot be started until the door and cover are shut and locked.

Another device, slightly different in detail, is shown separately.

*Lap Rollers.*—If the weights are on when the worker is turning the end of the lap round the roller at the starting of a new lap, fingers are liable to be caught in the lap, and the hand and arm wrapped round the lap roller The risk is met by a guard (as shown) which moves up and down with the weights and prevents access to the lap roller when the weights are on. Note the shaping of the edge of the guard by which the risk of the hand being caught between the guard and side plate is obviated.

*Calender Wheels and Cage Wheels* are guarded by a large substantial cast-iron cover, known as a " spectacle " guard, which encloses completely the toothed rims of the wheels, and has superseded the " nip " guards which covered the " intake " only and increased the danger by introducing a new risk of being caught between the toothed wheel and the edge of the guard.

*The Drop Wheel and Measuring Wheels* are enclosed in a complete fixed cover.

*Lap-forming end of machine lent by*—TWEEDALES & SMALLEY (1920), Ltd., Castleton, Lancashire.

## Carding Engine.

The carding engine completes the " cleaning " operations begun by the scutcher.

The machine unwinds the "lap" and passes it between the small diameter feed roller and feed plate to the *Licker-in*, which, having a toothed surface and rotating at a high speed, tears away the cotton and deposits it on the revolving *Cylinder*. The cylinder is covered with fine wire teeth, which hold the longer fibres whilst the short fibres and foreign matter are removed by the "*Flats*." The cotton is deposited by the cylinder on the "doffer," from which it is removed as a fine web by the *Doffer Comb* and passes on as a "sliver" through the *Coiler* and into the *Can*.

*Safeguards.*

The *Cylinder* has been the cause of many severe accidents. The wire teeth will drag down inside the casing anything which comes against them while the cylinder is running, and many fingers, hands and arms have been lost in this way when the door at the front was left open.

Formerly these doors were hinged at the bottom and were liable to fall open, which condition was masked by the curtain of strips from the flats which hangs down in front of the door. Accidents from this cause were reduced but not eliminated by hinging the door at the top: now they have been almost eliminated by locking devices which prevent (*a*) the door being opened whilst the cylinder is running, and (*b*) the cylinder from being started before the door is closed. One such device is shown in the exhibit. Arrangements have to be made, however, to allow the door to be open while the cylinder is being "stripped" (i.e., cleaned of foreign matter) and as the cylinder requires to be rotated for this purpose, safety is ensured by a device which prevents the driving belt from being put on to the fast pulley whilst the door is open, but leaves the cylinder free to be turned by hand as required. The door has also to be open when the cylinder wires are ground, but the risk of accident is negligible as the cylinder is rotated in the reverse direction, and the wires present a smooth surface to the hand.

Other safety points to be noted are:—(i) *Cover of Licker-in* screwed down, preventing access and eliminating another class of accident; (ii) *Train of Wheels* connecting the feed roller with the lap feed roller protected by coverguards; (iii) the *Side Shaft Pinion*, which drives the plate wheel, covered by a removable guard; (iv) the *Side Shaft Bevel Wheels* guarded by cover casting; (v) the *Train of Wheels from the Doffer and Carrier to Calender and Coiler* enclosed in a substantial casting; (vi) the *Barrow Wheel* guarded by a circular plate; (vii) the *Front Calender Wheels* and the bevel wheels working the coiler mechanism enclosed in casings having hinged covers and door; (viii) *Calender Wheels* in the coiler head separately guarded; (ix) the *Driving Pulley* of the plated and not of the spoke type.

The *Belt Fork* can be operated from the front or back of the machine. The plate fitted to the fork is a guard for the in-running side of the belt.

*Lent by*—PLATT BROS. & Co., Ltd., Hartford Works, Oldham.

## Carding Engine—Prevention of Dust.

Part of the short fibre and dirt in the cotton becomes embedded in the wires of the cylinder and doffer, and has to be removed two or three times a day. This may be done by a vacuum cleaner specially adapted to the operation, or by a mechanically driven revolving wire brush.

The vacuum cleaner method is illustrated by photographs on Screen III.

The second method is shown on the exhibit. The apparatus consists of a stripping brush and a cover which fits down to the machine, and is connected with the exhaust system by a pipe. Clouds of fine dust thrown up by the brush, which would otherwise escape into the air of the room, are carried away through the exhaust pipe to a dust collector. Waste cotton adhering to the brush has to be removed by hand by a wire-covered " strickle " (shown).

Other examples of this method are shown by photographs on Screen III.

*Stripping brush, cover and exhaust lent by*—GEORGE HARGREAVES & SONS, Ltd., Blackburn.

## Drawing Frame.

This machine receives the cotton in the form of " sliver " after carding, and by " drawing " lays the fibres parallel to each other and removes inequalities in the sliver.

Six sliver " ends " are drawn in through each head of the machine, and are elongated by passing them through the four pairs of drawing rollers into one " sliver " which passes on through the calender rollers into the can beneath the coiler head.

*Safeguards.*

1. The smooth *Undershaft* and *Coiler Shaft* are enclosed to prevent the hair or loose clothing of operatives being caught by the shaft.

2. The *Pulleys* are " plated," and the main driving pulley, with its belt, is securely fenced. The others are placed inside the frame of the machine.

3. *Cog-Gearing*.—The readily accessible cog wheels at the top of the machine are enclosed in three hinged covers so interlocked that (*a*) they cannot be opened whilst the machine is in motion, and (*b*) the machine cannot be started until they are closed.

The cog-gearing at the right-hand end of the calender rollers is protected by the cover over the rollers and the Coiler Head and Coiler Stand Cog-Gearing are enclosed so as not to be accessible whilst the machine is working.

The small bevel wheels driving the coilers and coiler shaft are guarded by a plate.

4. *Belt Fork Motions.*—The belt is prevented from creeping and so starting the machine accidentally (*a*) by the fact that the main belt fork is moved by a crank which is on " dead centre " in its two extreme positions ; and (*b*) by the fact that the strong spring which actuates the secondary belt fork motion from the fast to the loose pulley is always tending to push the belt on to the loose pulley

5. Two *Stop Motions* are shown :—

(1) The *Electrical,* which forms part of the design of the machine exhibited.

(2) The *Mechanical,* which for exhibition purposes is attached at the side of the machine.

Their purpose is to stop the machine when a defect in working has occurred, e.g., when the cotton becomes wound round the rollers (" lapping ") ; but they have also tended to diminish the risk of accidents from workers trying to remove the " laps " while the machine was running and getting their hands drawn in.

*Lent by*—HOWARD & BULLOUGH, Ltd., Accrington, Lancashire.

## Slubbing Frame.

(The exhibit is a shortened machine.)

Sliver from the drawing frame is passed through three pairs of " drawing " rollers to elongate the sliver : two " ends " pass through side by side, and on emerging, are lightly twisted together. The resulting " roving " passes through the hole in the top of the " flyer," down one of the flyer legs and out on to a " presser," which winds the roving on to the bobbin. The bobbin is given an up and down movement to produce even winding (movement not shown). The most serious accidents, including scalping, loss of fingers and hands, have occurred on the cog gearing.

*Safeguards.*

The *Headstock Gearing* is enclosed in the cupboard-like end of the machine, the door of which is so interlocked that it cannot be opened until the driving belt of the machine is on the loose pulley, and the belt cannot be put on to the fast pulley until the door has been closed.

The *Change Wheels* above the roller beam are inside a hinged cover, which is interlocked with the headstock door.

The *Twist and Carrier Wheels* outside the headstock enclosure are covered by a fixed casing.

The *Skew Gear Wheels*—of which there are two systems—(*a*) driving the bobbins, (*b*) driving the flyers—are protected by casing.

The *Roller Wheels* above the roller beam have fixed cover guards.

The *Lifter Racks and Pinions* which give the up and down motion to the " lifter " carrying the bobbins are enclosed in cast-iron covers.

The *Main Driving Pulley* is plated.

The eyes by which the *Balance Weights* are suspended form part of the casting, instead of being screwed in as formerly. Serious accidents were caused by the fall of the weights due to the screwed eyes giving way through vibration of the machine.

## Automatic Slip Wince.

Winces, which are rotating " drums " mounted on power-driven overhead shafts, are extensively used for the movement of cotton cloth in bleaching, dyeing and printing works. The cloth, which rides on them and is taken forward by their rotary motion, is frequently delivered on to a pile or into a kier or tank and, unless an automatic machine is used, a boy, known as a " plaiter-down," arranges the cloth evenly as it comes down from the overhead wince. Danger may arise when the cloth laps round the wince, instead of falling clear from it ; the part already deposited below is then wound up again, and the " plaiter-down " is liable to be entangled and taken up to the wince. A number of fatal accidents have occurred in this way.

The chance of the cloth lapping is reduced by filling in with wooden boards or " lagging " the spaces between the bars which form the drum, thus preventing the cloth becoming entangled round a particular bar.

The special safety feature of the wince shown is a " slipping clutch " between the wince drum and the driving shaft. The clutch may be set, according to the work the wince is to do, to give different degrees of resistance to slipping, and when any greater force, such as the weight of a boy, drags on the cloth, the clutch slips, and the cloth is not pulled up again to the wince. Winces with this safeguard are now widely used.

For demonstration purposes the wince is shown near floor level and is provided with a brake pedal which will apply to a belt (representing the cloth) a dragging effect such as would be caused by the weight of a boy entangled in it.

*Lent by*—GEORGE TAYLOR (BRASSFOUNDERS), Ltd., Bolton.

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# WOOL AND HAIR.

## **Sorting Screen** (Reduced Size).

This exhibit illustrates the arrangements required by the Home Office Regulations in the wool and horsehair industries in connection with the processes of opening the bales and sorting the wool or hair. In the case of material liable to be infected with anthrax, the dust given off during these processes constitutes a serious danger. The workers engaged in opening or sorting such material are protected by the opening or sorting being done over a screen or hurdle (as shown). The dust is drawn down through the screen by a strong exhaust and is then carried along the exhaust duct into the linen bag. The air passes through the fabric of this bag and the dust falls into the receptacle at the bottom and is subsequently burned.

At a wool sorting bench there would be a series of these screens.

*Presented by*—THE ROTO ENGINEERING CO. (BRADFORD), Ltd., Bradford, Yorks.

## **Worsted Spinning Frame** (Shortened Machine).

This machine, known as a "flyer" frame, is used for spinning worsted yarns. Work is carried on at both sides.

*Safeguards.*

The (*a*) cog-gearing, (*b*) chains and sprockets, and (*c*) belt drives are protected by covering guards which, in the case of parts requiring frequent access, are hinged and held closed by latches, and in other cases are permanently fixed.

The mechanical doffing appliance provided for removing full bobbins and substituting empty ones, though not designed as a safeguard, tends to safer working as the removal by hand of the bobbins produced a large number of cuts, bruises, scratches, etc.

*Lent by*—PRINCE-SMITH & STELLS, Ltd., Keighley, Yorks.

## **Loom.**

Used for weaving woollen, worsted and union cloths. The mechanism of looms used for weaving the heavier kinds of cotton cloths is similar.

The *Beam* carrying the warp rests on the brackets at the back of the loom. Each warp thread is led through one of the eyes in the *Healds*, then through its own space in the *Reed*, and forward to the cloth roller at the front of the machine. The weft yarn in the form of a *Cop* is held by the *Skewer* in the *Shuttle* and unwinds from this as the shuttle passes backward and forward across the *Slay*.

The *Dobby* motion at the top of the loom varies the sequence of lifting the warp threads in order to produce different weaves of cloth. The *Drop Box* on the left, holding several shuttles, allows wefts of different colours to be used to produce cross stripes of different colours in the cloth.

*Safeguards* are required both against the risks, common to many types of machine, from cog-gearing, spokes of pulleys, exposed projecting set screws, and against risks peculiar to looms, such as the " flying " of a shuttle and the breaking of a picking strap.

The safety devices are numbered :—

(1) Balance wheel or hand-wheel plated to avoid the risk of the worker being trapped between spokes and the connecting rod to the slay.
(2) Crank working dobby—set screws shrouded.
(3) Teeth of cog wheels working box motion guarded.
(4) Projecting set screw shrouded by hoop.
(5) Stop motion which stops the loom automatically if one of the picking straps break, thus preventing the uncontrolled motion of the picking stick and consequent risk of injury to the weaver.
(6) Cog-gear wheels driving the picking shaft covered.
(7) Driving pulleys are semi-plated.
(8) Set screw shrouded.
(9) Shuttle guard which either (*a*) prevents the shuttle from coming off the slay, or (*b*) deflects it downward so that risk of injury to the head is generally avoided.
(10) Taking-up roller or " sand " roller—which by its toothed surface puts a tension on the cloth and assists in pulling the warp off the warp beam—protected by board.
(11) Duck bills and heaters inside breast-beam protected by spring guards round heaters.
(12) Lever arrangement, operated from outside the loom, for releasing the catch avoids the necessity of putting the hand inside the loom.

*Lent by*—GEORGE HATTERSLEY & SONS, Ltd., Keighley, Yorks.

## Wing Guards.

" Wing " guards of strong wire mesh to intercept flying shuttles, thus preventing accidents to workers at neighbouring looms, are shown. This is an additional safeguard to the shuttle guard fixed on the loom itself (No. 9).

Specimens of guards of steel plate which have been in actual use and show numerous indentations caused by flying shuttles.

*Lent by*—WM. EWART & SON, Ltd., Belfast.

### " Ideal " Shuttle Guard.

Two laths are attached to the loom handrail by means of hinges and brackets, as shown. The laths form the top and side of a " tunnel " for the shuttle, and, as such, reduce the risk of the shuttle leaving the weft and causing injury. The laths are easily pushed inwards when the loom is stopped, and the first " pick " of the loom throws the guard into the " safe " or working position.

*Lent by*—LIGHTOWLER & KEIGHLEY, Ltd., Soho Mills, Thornton Road, Bradford.

### Beam Truck.

To obviate lifting and carrying of heavy beams by hand.

*Lent by*—JOHN HARDAKER, Ltd., Bradford.

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## SHUTTLE THREADING.

This exhibit shows some of the various devices which have been invented to supersede the long-standing practice in the cotton weaving industry of Lancashire of threading the shuttle by mouth suction. This practice, which is known as shuttle-kissing, consists in sucking the weft, which is made into a little bunch and placed in the nose of the shuttle, through the porcelain eye. Suggestions having been made that the practice might lead to the dissemination of tuberculosis or other infectious diseases, the matter was investigated by an Inter-Departmental Committee in 1912. The Committee reported that while no actual injury to

health could be established as resulting from the practice, the practice was undesirable and should, if possible, be abolished. The matter was then taken up by an informal Committee consisting of representatives of the Employers, Operatives and Factory Inspectorate. Their inquiries were interrupted by the War, but were resumed in 1919. Factories where new types of shuttles were in use with favourable results were visited and experiments were also instituted at selected mills. As a result of their investigation, the Committee reported that they were unanimous in recommending that shuttle kissing should be abolished and that they were satisfied that there were on the market several types of shuttles which afforded a practical solution of the difficulties that had hitherto existed.

The substitutes which have been devised and tried, fall into three groups :—(1) Those in which the shuttle is threaded by artificial suction ; (2) those in which the shuttle is threaded by hand ; and (3) those in which the shuttle is threaded by a hook or other mechanical device. The conditions that require to be fulfilled are that the shuttle must be satisfactory from the manufacturing point of view and that it cannot be threaded, or can only be threaded with difficulty, by " kissing."

The present exhibit, displayed partly on the table and partly in the case on the adjoining pillar, shows types of arrangements of each kind which are found in practice to be satisfactory.

Of the exhibits on the table, Nos. 1, 4 and 7 are appliances with which an ordinary shuttle cannot be used. No. 1 is an appliance for artificial suction and the eye of the shuttle is so constructed that if an attempt is made to thread it by " kissing," the thread is drawn through the top aperture and then it will not weave. No. 4 is a mechanical threader ; though it is possible to " kiss " this shuttle, it is much easier to thread it by using the small hook threader (like a reed hook), which can be fitted to any loom at the cost of a few pence. No. 7 is also a mechanical threader and the shuttle has to be adapted so that the threader can be used. This method is a modification of one devised by a working weaver who used a bent wire with an eye at one end through which was threaded a piece of coarse worsted ; the wire was passed through the nose of the shuttle and out at the eye, and the fibrous nature of the worsted thread drew the cotton weft after it.

Nos. 2, 3, 5 and 6 on the table are suction appliances. They can be used with the ordinary types of shuttle without loss of efficiency, but they are subject to the drawback that the habit of using the mouth is difficult for the weaver to break off, and he may experience some loss in output until he becomes accustomed to the use of the appliance.

The case contains eight shuttles of special design, which can be threaded by hand—five of these were passed as satisfactory by the Joint Committee, and three have been designed since the Committee reported.

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## PHOTOGRAPHS.

Methods of fencing and of dust prevention in connection with textile machinery are shown on Screen III.

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## MANUFACTURE OF POTTERY.

The chief dangers in this industry arise (1) from the use of lead in glazes and colours, which gives rise to lead poisoning; (2) from the dust created in some of the processes, which gives rise to the disease of the lungs called "silicosis" (sometimes locally called "potters' rot").

The exhibits show the plant used in four important processes where these dangers exist, and the methods by which the workers are protected. These processes are—

(*a*) Towing of Earthenware in the Clay state.
(*b*) Brushing of Earthenware in the Biscuit state.
(*c*) Ware Cleaning after Dipping.
(*d*) Aerographing.

All the processes are shown connected up to an Exhaust Installation which removes the particles of lead glaze, dust, etc., at the point at which they are given off in the processes and so protects the worker from inhaling them.

The towing and brushing spindles are driven by an endless rope-drive properly fenced.

Two smaller exhibits are shown separately, viz. :—

(*e*) a grooved mould to minimize risk of dust in the making of self-scrapping flat-ware ;

(*f*) a method of obviating the use of flint dust when making fine china-ware in the clay state.

A separate descriptive notice is attached to each exhibit.

## (*a*) Process of Towing.

Flat articles of Earthenware, in the Clay state, are fettled or finished by rubbing the surface with an abrasive, such as a piece of sandpaper or a lump of tow, whilst the article rotates on a suitable head mounted on a vertical spindle. Owing to the dust which is given off from the earthenware body, the operation of Towing is required by the Home Office Regulations to be done in a suitable hood connected with an efficient exhaust draught, as shown in the exhibit.

*Hood and Exhaust apparatus lent by*—THE POTTERIES VENTILATING AND HEATING Co., Tunstall.

*Spindle and head, with rope-drive for same and knee-push for setting head in motion lent by*—WM. BOULTON, Ltd., Burslem.

## (*b*) Process of Brushing Biscuit Earthenware.

Flat articles of earthenware are placed in sand for their first firing and emerge therefrom in the Biscuit state with particles of sand adhering to them. These sand particles are removed by brushing and, as they are injurious to the lungs if inhaled, the brushing needed to remove them is required by the Home Office Regulations to be done with a localized exhaust draught, unless other provision for ventilation is made to the satisfaction of the Factory Inspector.

The exhibit shows a pair of brushes, one convex and one concave, mounted on power-driven spindles. Plates are brushed by pressing the under side into the concave brush and the upper side on to the convex brush. The dust generated is removed locally through an oval hopper fitted round the revolving brushes.

*Exhaust apparatus lent by*—THE POTTERIES VENTILATING AND HEATING Co., Tunstall.

*Double-headed brushing machine with rope drive and knee-push for setting brushes in motion lent by*—WM. BOULTON, Ltd., Burslem.

## (*c*) Process of Ware Cleaning after Dipping.

After biscuit-ware has been dipped in glaze, it is generally necessary to remove any excess of glaze from certain portions of the ware. Unless this can be done exclusively under wet conditions, particles of dry glaze containing lead are given off during the process, and it is accordingly required by the Home Office Regulations to be carried on with an exhaust draught, to prevent the worker inhaling the dust. The Regulations also require the provision of a water-surface to catch the heavier particles of glaze which are not removed by the fan.

The exhibit shows a downward exhaust draught acting through a grid which is completely surrounded by a water-surface. Supports are provided for carrying a board of ware in such a position that it will not interfere with the proper use of the exhaust grid and the water-surface.

*Lent by*—THE POTTERIES VENTILATING AND HEATING Co., Tunstall.

## (*d*) Process of Aerographing.

This process is widely used for blowing a fine spray of colour on to either biscuit or glost ware ; it is also used, to a less extent, for blowing glazes on to ware. To protect the worker against the dispersal of the fine spray in the air which he is breathing, the work is required by the Home Office Regulations to be done in a suitable hood fitted with an efficient exhaust draught. In recent years, compressed air under relatively high pressure has been used to work the aerographing or blowing instrument ; this has necessitated a proportionate increase in the standards of exhaust.

*Hood and exhaust apparatus lent by—*
THE POTTERIES VENTILATING AND HEATING Co., Tunstall.

## Exhaust Installation.

Consists of an exhaust duct drawing air from four branches, viz., one from each of exhibits (*a*), (*b*), (*c*) and (*d*). The diameter of the main duct is suitably graduated ; the branches enter at easy angles to facilitate the flow of the air current and prevent obstructions and the whole is connected to a $12\frac{1}{2}$ in. fan, the outlet of which discharges into the open air.

In actual practice a bag-filter, cyclone or other collector would be fitted.

*The whole installation supplied and erected by—*
THE POTTERIES VENTILATING AND HEATING Co., Tunstall.

## Endless Rope Drive.

The exhibit shows a standard method of driving a number of small machines by means of a single endless rope kept in continuous motion through one or more workrooms, each machine being set in motion, as required, by means of a knee-push which causes the rope to engage with a pulley on the spindle of the machine.

Fencing is needed for the rope wherever it is dangerously exposed, especially at the intake of guiding or jockey pulleys and at the " tension " frame ; in long drives the tension frame consists of a pulley and counter-weight moving on vertical guides, whereby the appropriate tension of the rope is maintained whether the latter be at rest or in motion ; in short drives, such as the one exhibited, sufficient tension is maintained by a sliding tension pulley underneath the bench.

*The rope drive, complete with tension, guide pulleys and accessories, lent by*—
WM. BOULTON, Ltd., Burslem.

Other exhibits are :—

## Grooved Mould for Self-Scrapping Flat-Ware.

Self-scrapping flat-ware is made on moulds which are so sloped that the finished article, as it dries, shrinks away from the waste or scrap which remains behind round the outer edge of the mould. When such moulds are removed from the drying stoves the scrap is liable to fall off on to the floor, causing dust as soon as it is trampled on. The deep groove is so designed as to retain the scrap on the mould until it is deliberately removed by the worker at a place where it will fall into a suitable receptacle.

The exhibit shows an ordinary self-scrapping plate mould and beside it a similar mould with the groove to keep the scrap on the mould whilst being handled.

*Given by*—T. SIMPSON, SOHO POTTERY Co., Ltd., Cobridge.

## Board with Flannel Strips.

In potters' shops where fine china articles are made, it has long been the practice to dust over the boards with a layer of finely-powdered flint, which prevents the clay articles from being damaged by contact with the board itself.

Every motion of air in the workroom tends to blow the fine flint particles into the air, thus increasing the risk of silicosis. It has been found that this use of flint dust can be dispensed with if two strips of felt or flannel are fastened on the board, lengthwise, so that each article rests on both strips.

*Given by*—DOULTON & Co., Ltd., Burslem.

### Quartersize Model of Dust Extraction Plant for Cradle Filling Benches in Scouring Shops.

Cradles for holding the ware in the scouring drums are filled at this bench, the special feature being the exhaust connection at the back of the bench. The exhaust draught carries away the light flint dust which rises while the ware is being placed, whilst the heavy dust falls into the trough.

This type of bench is now in use at Mintons, Ltd., Stoke-on-Trent.

*Lent by*—SUTCLIFFE VENTILATING & DRYING Co., Ltd., Manchester.

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## PHOTOGRAPHS.

Processes in the manufacture of pottery, as carried on in accordance with the Home Office Regulations, are shown on Screens XIII and XVI in the Gallery.

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## CHAFF-CUTTING MACHINE.

This well-known machine is used in forage factories as well as on farms, private estates, etc., for cutting hay for animal fodder. The material is fed, either by hand or mechanically by lattice feeds (as shown), to the pair of ingathering spiked feed rollers and so carried to the cutting knives which are fixed on the spokes of the large flywheel.

*Prevention of Accidents.*—The chief danger of the machine arises from the spiked feed rollers and the knives on the flywheel. If, when feeding, the hands are pushed too close to the rollers they may be trapped and carried forward to the knives. The introduction of power for driving these machines has increased both the frequency and severity of the accidents. The Chaff-Cutting Machines (Accidents) Act, 1897, which

applies to all power-driven chaff-cutting machines whether in factories or elsewhere, requires the feeding *Mouth* or *Box* to be so constructed or fitted as to prevent the hands or arms from being drawn between the rollers to the knives. In the exhibit, this is effected by fitting the feeding box with a reversing mechanism. Before the operator's hand can advance too near the rollers the arm or shoulder is brought up against a crossbar and the pressure on this operates the device which reverses the rollers and so prevents the hand being drawn in.

The Act further requires the flywheel and knives to be securely fenced. The exhibit shows them enclosed by a hinged cover.

The various gear wheels and the spindles on which they are mounted are completely guarded by well-fitting cover guards. A suitable cover guard is also provided for the short upper lattice. This prevents access to the rollers from behind the reversing crossbar.

*Prevention of Dust.*—Chaff-cutting is a very dusty process, and this machine is provided with means for separating and removing the dust direct from the chamber containing the knives. On one side of the chamber is a perforated metal plate which is continuously cleaned by a revolving brush and through which the dust is sifted away by means of a fan driven from the machine shaft. From the fan the dust is blown through a duct to a dust settling chamber (chamber not shown).

*Lent by*—BAMFORDS, Ltd., Uttoxeter, Staffs.

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## SPRAYING PLANT FOR APPLICATION OF CELLULOSE LACQUERS.

Cellulose Lacquers are now extensively used in many industries, e.g., motor coachwork, furniture-making, pottery, bootmaking.

The lacquers are made by dissolving cellulose nitrate or cellulose acetate in solvents such as amyl acetate, butyl acetate, acetone, or benzol, and adding gums, pigments, etc.

The lacquer is most frequently applied as a spray, and in view of the nature of the solvents, most of which are highly inflammable and have toxic properties, it is necessary to take precautions for the prevention of explosion and fire and for the protection of the worker. The risks arise mainly from the vapours given off by the volatile solvents in the process of applying the lacquer, and from the splashes of lacquer which form inflammable deposits at the place where the work is being done.

The exhibit shows an arrangement for spraying small articles. For large articles, such as motor-car bodies or pieces of furniture, a special room or booth takes the place of the cubicle (*see* below), but the methods of guarding against the risks are the same in principle.

The spraying is done within the cubicle, at the back of which is an exhaust fan to remove the vapours as they arise and to draw them away from the operator. The article to be treated is placed inside the cubicle and the lacquer applied by means of the spraying pistol. The lacquer is contained in the cup of the pistol and passes out through the central orifice in the nozzle. As it leaves the nozzle it is caught by jets of compressed air brought through the passage in the pistol handle, and converted into a fine spray.

*Precautions.*

The fan should be of adequate size to produce an inward air speed of at least 75 ft. per minute at any point in the plane of the front of the cabinet. Direct exhaust ventilation to the outer air without the intervention of ducts is best, but where this is impracticable, the ducts should be as short as possible so as to minimise resistance to the fan's action and should be provided with means of easy access for cleaning.

All parts which are splashed by the spray must be frequently cleaned, and, in the case of iron and steel parts, this should be done by means of non-ferrous scrapers or fibre brushes so as to obviate the possibility of a spark being produced mechanically.

As the risk of the formation of an explosive mixture of vapour and air can never be entirely eliminated, the use of naked lights must be absolutely prohibited near the work, and all electrical equipment must be installed and maintained so as to obviate the possibility of ignition by a spark or arc. Motors, fuses, starters and switches must not be inside or near the cubicle unless they are of a flameproof type, and all wiring, including that of pendant lamps close to the cubicle, should be protected by steel conduit.

As a further precaution the cubicle should be constructed of fire-resisting material, such as metal (as in this exhibit), compressed asbestos slabbing, or wired glass so as to retard an outburst of flame should ignition occur.

*Complete cubicle and non-ferrous scrapers lent by—*
THE AEROGRAPH Co., Ltd., Lower Sydenham, S.E.26.

*Exhaust fans for use in spraying cubicles lent by—*
J. KEITH & BLACKMAN Co., Ltd., 27, Farringdon Avenue, E.C.4,
DAVIDSON & Co., Ltd., Belfast.

*Cellulose lacquer container lent by—*
A. E. WESTWOOD, Ltd., 65, New Street, Birmingham.

*Naphtha well lent by*—DOULTON & Co., Ltd., Lambeth, S.E.1.

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## PHOTOGRAPHS.

(*a*) Spraying room for motor cars. *Given by*—ROBERT KEARSLEY & Co., Ripon.

(*b*) Results of an explosion at an enamel sign factory.

*Reference.*

Memorandum on the manufacture, use and storage of cellulose solutions, published by H.M. Stationery Office (Factory Form 826).

Home Office Cellulose Spraying Regulations, 1934.

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# INDIARUBBER MACHINERY.

## Rubber Rolls.

Hollow metal rolls, sometimes termed " bowls," set close together, are extensively used in the rubber industry for washing, warming up or masticating the crude rubber, mixing or incorporating various materials with it, calendering rubber sheeting, etc. The rolls may be set in a horizontal plane (for masticating, mixing or incorporating, grinding), in a vertical plane (for calendering), or sometimes in an inclined plane (for washing). The roll surfaces are usually smooth but indented surfaces are also used. The exhibit is a two-roll machine of the vertical or calender type, for the treatment of crepe rubber.

Many severe, and some fatal, accidents are caused by the hand of the worker being trapped in the ingathering rolls. This may be due to carelessness on the worker's part in working the rubber too close to the " nip " of the rolls or to the rubber gripping and carrying the hand towards the " nip."

The problem of providing protection for the worker on rubber rolls is rendered difficult by the fact that he must perform much of his work on the revolving roll itself.

In 1923 an agreement was reached between the Home Office and the India Rubber Manufacturers' Association that horizontal rolls should be guarded by bars or plates which keep the worker in the ordinary course of work from approaching the "nip," or alternatively by a guard at the "nip"; but, unfortunately, similar methods of protection are hardly practicable in the case of the ordinary vertical calender. (In the machine exhibited, which is used for a special process not requiring work to be done at the rolls, complete protection is afforded by the transparent plate guard shown). Moreover, in the case of horizontal rolls, the risk of the worker getting his hand gripped by the rubber and being drawn in over the roll remains. It is necessary, therefore, that all rubber rolls should be furnished with efficient quick-stopping arrangements, by means of which the worker, even if trapped, can stop the machine without delay. A complete apparatus for this purpose is provided for the machine exhibited which embodies the following features :—

(1) The trip gear can be operated by hand or by foot, from either side of the machine, and from any position between the "housings." Trip switches which are sometimes adopted may not—especially on wide machines—be within reach of a trapped worker; and wires ("life lines") stretched across the machine are therefore to be preferred.

(2) The operation of the trip gear, in addition to disengaging the clutch, also applies the brake, thus rendering the stoppage practically instantaneous.

(3) Re-setting of the trip mechanism can be expeditiously performed by means of the low hand-wheel.

Where a range of machines is driven from a single motor, a continuous "life-line" can be provided so that any worker can, without delay, stop the entire range without moving from his working position.

The dangerous gear wheels of the machine shown are completely enclosed with satisfactory guards and the clutch protected with a suitable rim guard over the top.

*Lent by*—DAVID BRIDGE & Co., Ltd., 35, Queen Victoria Street, London, E.C.4.

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## PHOTOGRAPHS.

Guards for rubber rolls. *Given by*—LEYLAND & BIRMINGHAM RUBBER COMPANY, Leyland.

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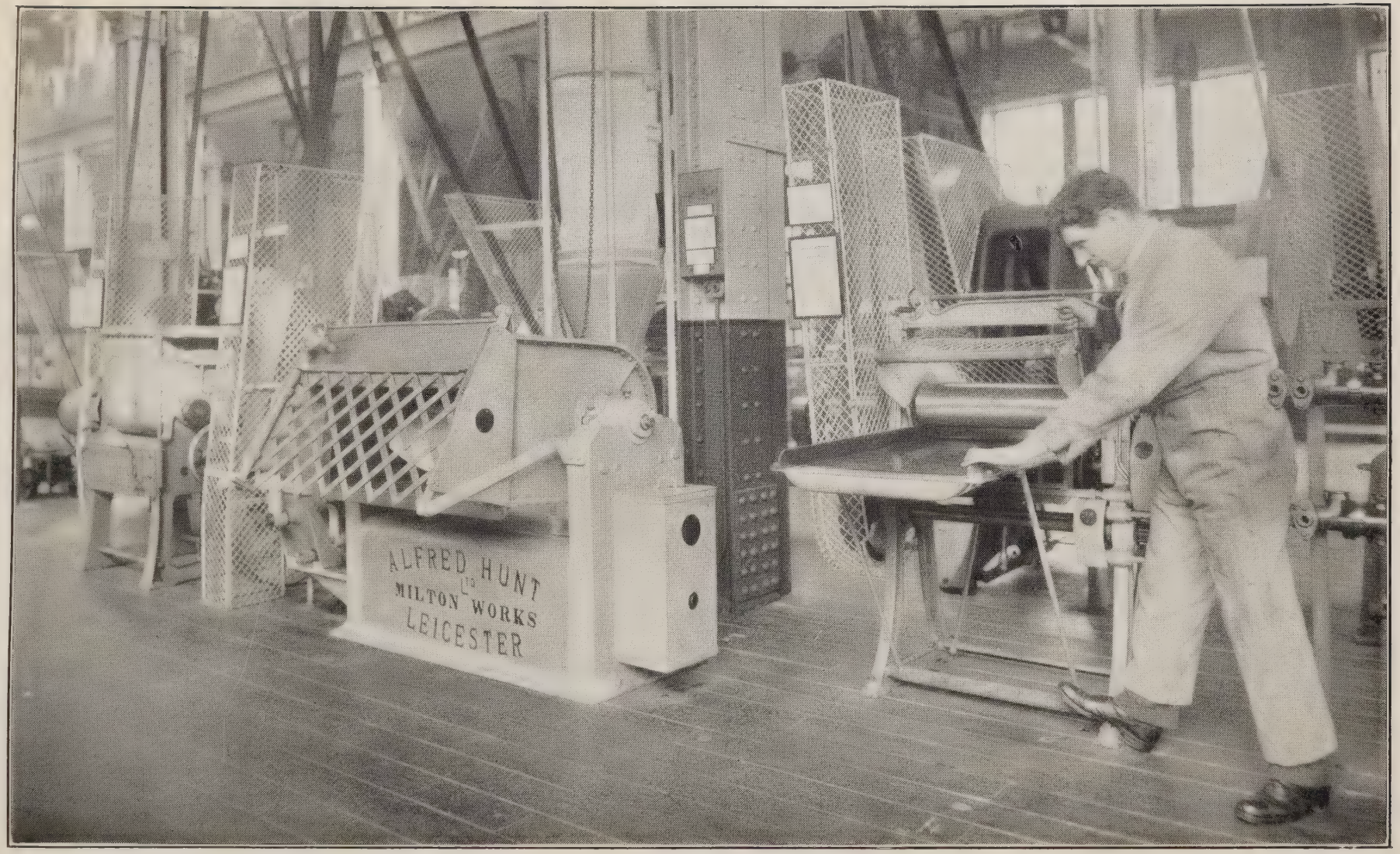
*To face p. 45.*




BAKING SECTION.

In centre, Large Mixer, in tilted position. On stanchion behind, push buttons for stopping and inching shafting.
On right, Dough Brake ; on left, Cake Mixer.

# BAKEHOUSE MACHINERY.

## Dough Mixer.

Most of the more serious accidents on dough mixers occur on the trough type, and are caused by the worker putting his hands into the machine while the arms are revolving, either to " feel " or test the dough, or to assist its removal when mixing is completed. Such accidents can be prevented by fitting closely over the opening in the trough a cover which, by an interlocking arrangement, (*a*) must be closed before the mixer arms can be put into operation, and (*b*) cannot again be opened until the arms have been stopped.

It is necessary, however, (unless the dough when mixed can be removed from the trough by hand whilst the arms are locked) so to arrange the cover that it can be opened, when the trough is tilted, to the extent necessary for the dough to be discharged by the power-driven arms. This space should not be so wide that the worker's hand can be inserted far enough readily to reach the arms ; and the spaces, too, between the partially open cover and the sides of the trough should also, in order to prevent the insertion of the worker's hand, be filled in with side cheeks.

The machine exhibited is designed to meet these requirements. The lattice cover is connected by a special device with the control lever, and to enable the lever to be moved to set the mixer in motion the cover has to be closed. Moreover, when the trough is tilted the cover is only partially opened. A detailed description of the mechanism on a very similar machine is given in Home Office Safety Pamphlet No. 10, page 4.

*Lent by*—ALFRED HUNT, Ltd., Milton Engineering Works, Leicester.

## Cake Mixer.

This machine is similar in construction to a dough mixer, but as it is designed to deal with thinner material than a dough mixer, it can be emptied by hand when the machine is at rest. The cover is locked when the trough is vertical and the blades are in motion.

*Lent by*—THE MORTON MACHINE Co., Wishaw, Scotland.

## Dough Brakes.

These machines are more common in Scottish than in English bakehouses, and are widely used in biscuit factories. The serious accidents are usually due to the worker getting his hand caught between the rollers —either in front or at the back—when feeding up the dough, or when cleaning the rollers.

The irregularity in the shape and size of the lumps of dough makes rigid guards generally impracticable, but satisfactory guards have now been devised consisting of a grid, placed on each side of the rollers, which, on the hand or arm of the worker coming into contact with it, actuates a mechanism that causes the rollers to be stopped or reversed.

A guard of the reversing type is shown on the machine exhibited. The hood guard which swings on pivots is connected with the clutch gear and is brought into the safety position on whichever side at the moment the rolls are intaking by the operation of the starting lever attached to the guard. The lifting of the guard immediately stops and reverses the direction of motion of the rolls.

*Lent by*—THE MORTON MACHINE Co., Wishaw, Scotland.

### PHOTOGRAPH.

An adjustable fixed guard for a dough brake. *Supplied by* A. Gillespie & Sons, Ltd., Kinning Park, Glasgow.

## Meat Mincing Machine.

Many serious accidents at meat mincing machines have been caused through workers using their hands to press the meat down the feed-throat of the machine instead of using the push stick, or through inserting their hands into it when cleaning the machine, with the result that their hands have been badly mutilated by the revolving worm.

Grids, attached to the feed tray by set screws, have been used to prevent this, but it has been found that the grids are sometimes removed, especially for cleaning purposes.

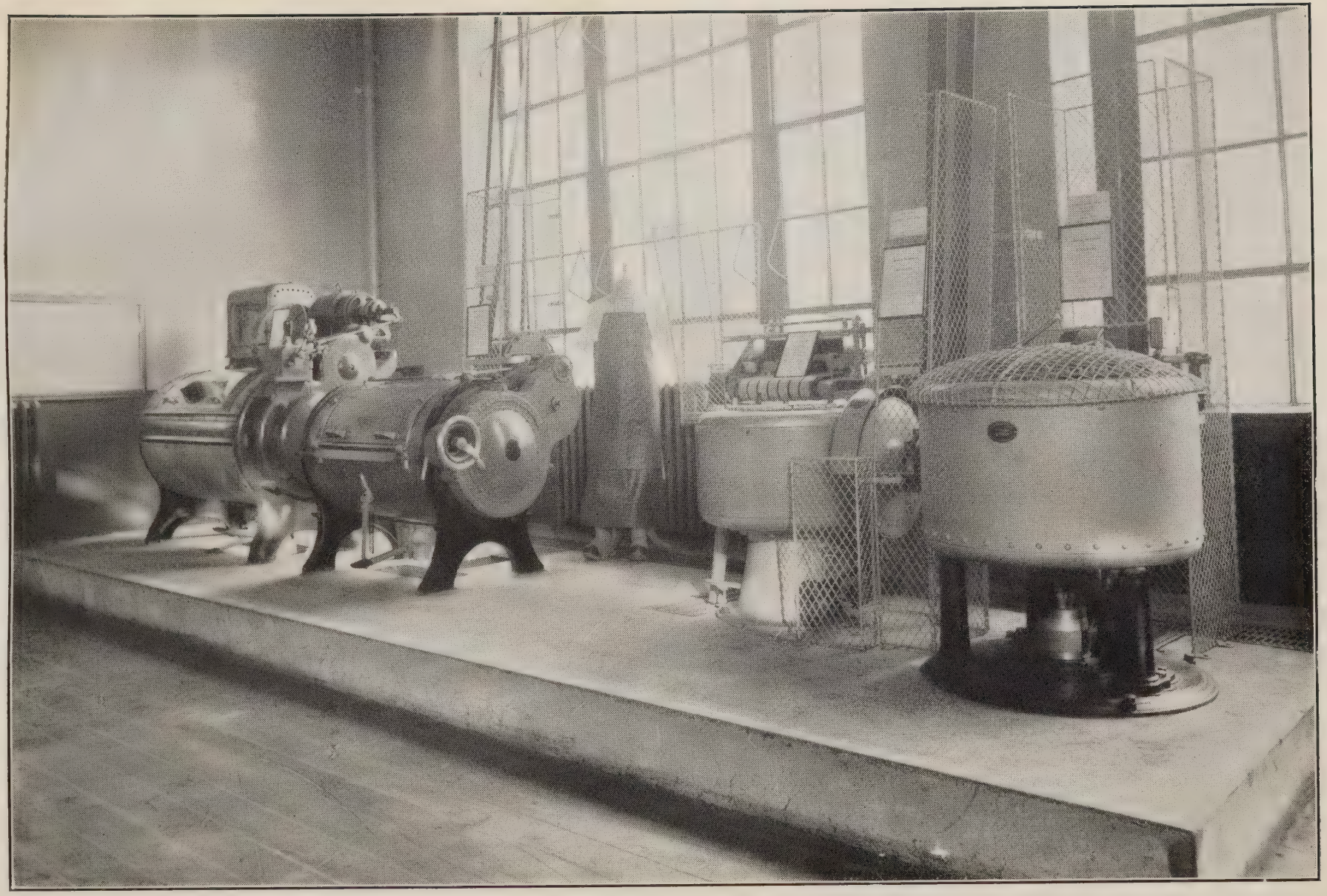
In the machine exhibited the danger is prevented by having a feed-throat with only a $2\frac{1}{8}$--in. opening at the top, and extending for a distance of 7 in. above the top of the worm. With a feed-throat of this type, access of the fingers to the worm is impossible and it has been found that output is not appreciably reduced.

It will be seen that the feed-throat and worm casing are made in one piece, so that the removal of the feed tray does not entail exposure of the worm.

Being electrically driven the machine requires to be earthed.

*Lent by*—HOBART MANUFACTURING Co., Ltd., Charterhouse Street, E.C.1.

*To face p. 47.*



LAUNDRY SECTION.

Washing machines (left); hydro extractors (right). Impervious floor, with channels to carry off wet.

## Syphon Head Cleaning Box.

Serious injuries may arise from the bursting of a syphon whilst the fitting is being cleaned and polished. This risk is reduced if the syphon is held in a suitable box or case.

The exhibit shows a type of cleaning box which encloses the syphon but allows the head to be easily cleaned.

*Lent by*—THE DIRECT SUPPLY AERATED WATER Co., Ltd., Fulham Palace Road, W.6.

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*GROUND FLOOR—RIGHT OF ENTRANCE.*

## LAUNDRY MACHINERY.

The Laundry Industry—which is almost entirely a women's industry—has been largely revolutionised since the beginning of the century by the greatly extended use of power.

The substitution of the machine attendant for the hand laundress of the past, has brought with it, unfortunately, risks of serious accidents from the nature of the machinery employed. Though these risks have been largely reduced through the efforts of Factory Inspectors and the industry working in co-operation, accidents of a serious nature occur. In the two years 1931–2 there were 9 fatal and 923 non-fatal accidents.

The exhibit, which includes the chief types of laundry machinery, illustrates the dangers to which the workers are exposed and the best methods at present available of preventing them.

*Reference:—*

Home Office Safety Pamphlet, No. 11, obtainable from H.M. Stationery Office.

## Washing Machines (2).

Several types of power-driven machines for washing clothes, etc., are in use in laundries ; the rotating type, of which two kinds are shown, is the most common. The machine consists of an inner and outer cage. The clothes to be washed are placed in the inner cage, which is filled with water, soap, etc., and rotates in each direction alternately.

Accidents with washing machines have occurred owing to the hands or fingers of the operator coming into contact with the revolving cage ; or by the heavy door of the cage falling forwards on the arm or hand while clothes are being put into or taken out of the cage.

There is also the risk, common to all power machinery, from the gearing, etc., of the machine.

1. In this exhibit the machine is wholly controlled, as far as the operator is concerned, by the " master switch," which has only two definite positions—on and off. When the " master switch " is placed in the " on " position, the inside cage commences to revolve and to reverse ; during this process *the outer door is locked by a safety stop and access to the inner cage is impossible.* On throwing the " master switch " to the " off " position, the cage ceases to revolve for the moment, and a slow speed motion immediately comes into action and slowly turns the cage until the door is in the unloading position. The inner cage is then automatically and definitely locked in position by means of the brake and the safety stop is released, allowing the outer door to be opened and the machine unloaded and reloaded. A signal lamp shows when all current is " off " and the machine ready to be opened up. When the outer door is opened it is impossible to apply any current whatever to the machine, and no current is available until the outer door is definitely closed.

*Lent by*—ISAAC BRAITHWAITE & SON, Engineers, Ltd., Kendal.

2. In this exhibit a locking device is attached to the hand-turning gear for the inner cage by means of which the cage may be firmly locked in any position. If the cage is locked when the door of the inner cage is immediately opposite the door of the outer casing, the risk of the heavy door of the inner cage falling down on the hands or fingers of the operator is minimised. The locking device also prevents the hand-turning gear being put into mesh while the cage is rotating.

The outer casing of this exhibit is provided with a sliding door fitted with good hand-grips in place of the old type of hinged door, which was liable to fall. Note also the apron to prevent garments falling between the cage and the casing.

The side gearing of the machine is enclosed by a metal cover.

*Lent by*—D. & J. TULLIS, Ltd., Clydebank.

## Wringing Machine.

Many serious accidents resulting in crushed hands and arms have been caused by the hand of the worker, while "feeding" the clothes into the "nip" of the rollers, becoming entangled in the clothes and drawn in. These accidents can be prevented by providing, as in this exhibit, a guard so arranged that, should the worker's hand inadvertently approach the "nip" of the rollers, the hand will push the guard plate forward, and set in motion a device which stops the rollers automatically. A supplementary safeguard which is very desirable is the provision of a travelling band, as shown, which will carry the wet clothes to the "nip" and so render it unnecessary for the worker's hand to approach the rollers. (N.B.—It has not been possible to show the length of the band feed which is advisable in actual practice.)

*Lent by*—LOUD & WESTERN, Ltd., Broughton Road, S.W.6.

## Hydro-Extractors (2).

Wet clothes are packed in the cage of the machine which is rotated at a high speed, and the water extracted from the clothes by centrifugal action. Many serious accidents have been caused by workers coming into contact with the rotating cage of a hydro-extractor or with the clothes in the cage. These accidents can be entirely prevented by providing the machine with a cover so fitted that the cage cannot be set in motion until the cover is closed and the cover cannot be lifted as long as the cage is in motion.

1. In this exhibit (speed 1,650 revolutions a minute) a double safeguard is provided by means of (1) a handle which is so connected with the belt fork that when pushed back to open the cover, the belt is moved from the fast to the loose pulley, and (2) a catch which cannot be raised until the cage is at rest.

*Lent by*—WATSON, LAIDLAW & Co., Ltd., Glasgow.

2. This exhibit (speed about 1,500 revolutions a minute) is fitted with a locking device which prevents the power being applied when the cover is open and prevents the cover being lifted when the cage is in motion.

*Lent by*—THOMAS BROADBENT & SONS, Ltd., Huddersfield.

### PHOTOGRAPHS.

Fencing for hydro-extractors is shown on the screen.

## Floor.

The floor under and around the washing machines, hydros, and wringers in a laundry is usually wet, and workers are liable to slip and meet with accidents on such floors, as well as to suffer in health from wet feet. The floor should accordingly be made of impervious material and the Factory Acts require that it shall be so drained that the water is carried away freely. The washing machines and hydros exhibited are accordingly shown standing over sumps which communicate with a common drain channel at the back, and the whole floor is also sloped towards the drain so as to drain off any water. The drains are covered by grids to prevent workers inadvertently stepping into them. (N.B.—It has not been possible to show the sumps of the depth which would be necessary in actual practice.)

## 4-Roll Calender.

A machine for ironing flat articles, the articles being passed under the rolls and over a bed which is heated by steam (approx. 250° F.). Many serious accidents have been caused by the worker's hands being drawn in and crushed and burned between a roll and the bed. The accidents may happen either at the front roll while the worker is feeding articles into the machine or at a back roll when an article sticks to a roll and comes up between the rolls and the worker attempts to push it back into place under the rolls. Accidents at the front roll can be prevented by providing, as in this exhibit, a finger plate in front of the feeding " nip " which is so arranged that should the worker's hand inadvertently approach the " nip " of the rolls the hand will push the guard plate forward and set in motion a device which stops the machine automatically.

A supplementary safeguard which is very desirable for the front roll is the provision of a tape feed which carries the article towards the " nip."

Accidents at the back rolls can be prevented either—

(*a*) by fixing stout wire netting over the rolls ; or

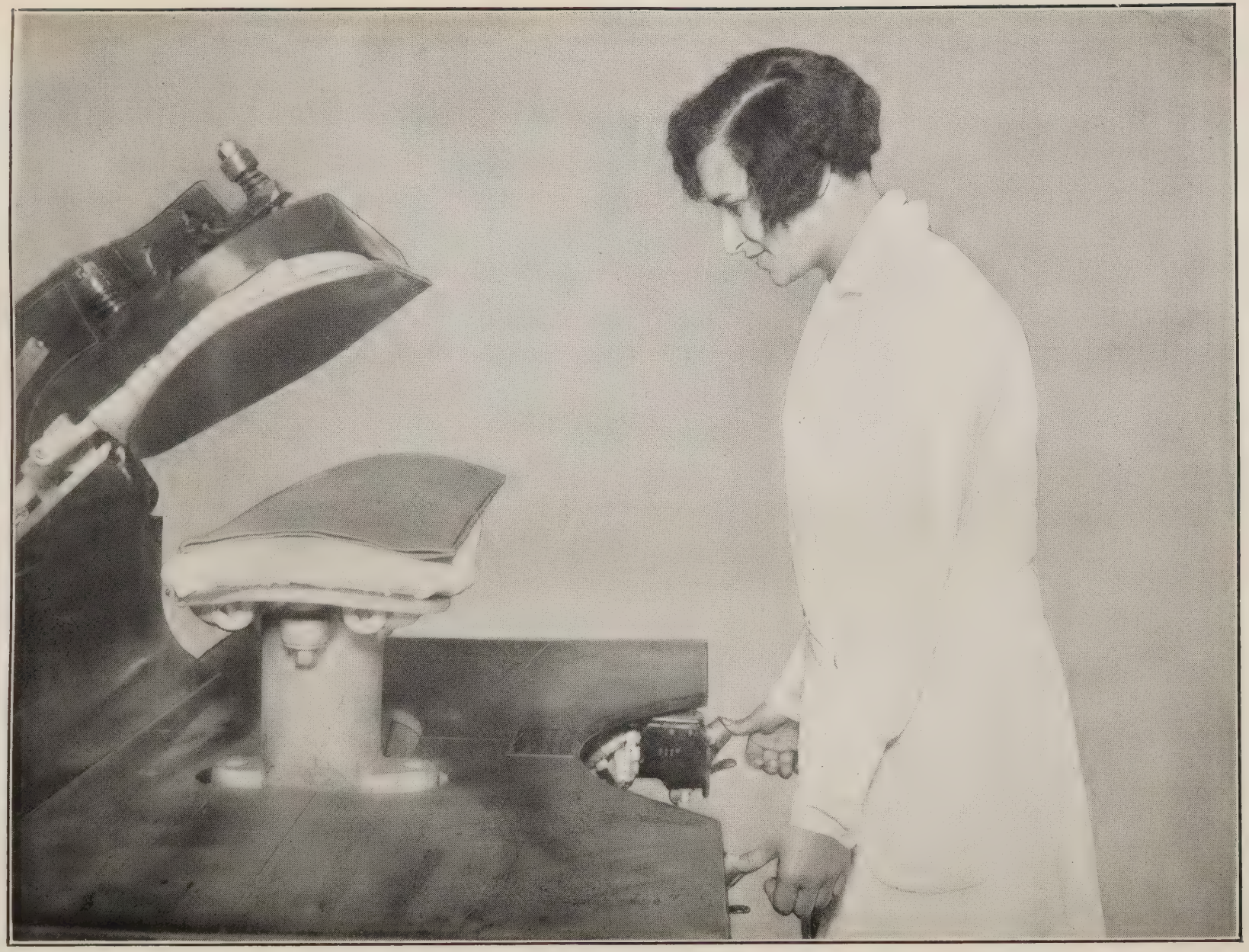
(*b*) by a vertical side guard.

Both methods are shown in this exhibit.

Tapes should also be bound round the rolls in the manner shown so as to hinder the articles from coming up between the rolls.

Photographs of fencing for calenders and ventilation systems for calender rooms are shown on the adjacent screen.

*To face p. 51.*



LAUNDRY SECTION.

Pneumatic Press with double hand-controls.

## Garment Presses (2).

One method of ironing articles by machinery is to place them between two plates (one heated), which are then brought together under pressure. Bad accidents may be caused by the worker's hands being caught and crushed and burned between the plates. Two such presses are exhibited.

1. "Twin Rapid." This exhibit shows one method which has been devised to prevent these accidents. Two plates (for alternate use) are fixed on a table which is revolved by hand; the article to be ironed is placed on one or other of these plates, is brought by the revolution of the table under the heated upper plate and pressed against it by means of the ram. The operator is safeguarded partly by the distance at which she stands from the pressure "nip," and partly by the fact that the article has not to be fed by her between the pressure plates.

The distance at which the worker stands from the heated upper plate also reduces considerably the discomfort from the heat radiated from this machine.

*Lent by*—BROWN & GREEN, Ltd., Luton.

2. "Pneumatic." Another method of preventing these accidents is to fit the machine with a device which entails the employment of both hands outside the danger zone in order to bring the press into operation. In the exhibit this is effected by having double control push buttons, so arranged that both hands are needed to operate them. If after pressing both buttons, and while the upper plate is in act of descending, one push button be released, the upper plate will stop descending and return to the open and safe position.

Discomfort due to radiation of heat from the plate is reduced by means of insulating material fitted between the plate and the metal cover above it.

*Lent by*—ARMSTRONG & Co., Ltd., Queen Victoria Street, London, E.C.

## 4-Roll Collar Polishing Machine.

A machine used for polishing collars by passing them between hot rolls which revolve under pressure and which are maintained at a temperature of about 275° F. Serious accidents have been caused by the hand being drawn in and crushed and burned between the hot rolls. These accidents may occur when the collars are being fed between the rolls, but more often when the worker is clothing the rolls (i.e., putting the cover on the larger rolls), or cleaning the smaller steel rolls while they are in motion by power. Accidents due to the first cause can be prevented by providing

a slot guard in front of the " nip," the slot of which is so narrow that it is impossible for the worker's fingers to reach the " nip." The upper and lower plates forming the slot are extended to prevent the fingers being placed between the edge of the guard and the upper or lower rolls. Accidents due to the second cause can be prevented by attaching to the slot guard an inter-locking arrangement which prevents the removal of the guard from its correct position in the front of the rolls until the machine is stopped, i.e., by the driving belt being placed on the loose pulley. Access to the back of the rolls (where there is equal danger) is prevented by means of a sheet metal guard which is interlocked with the driving pulley in a similar manner to the front slot guard. All these safeguards are shown in the exhibit.

Since it is difficult to clothe or clean the rolls whilst the machine is at rest, i.e., when either guard is open and the belt on the loose pulley, a handle is provided by means of which the rolls can be rotated by hand to facilitate these operations.

## Shirt and Collar Ironer (Traversing Table Type).

A machine for ironing collars and shirt fronts, the articles being placed on the table which travels backwards and forwards under the hot roller (275–300° F.). The worker's fingers are liable to be drawn in between the roller and the table and to be badly burned or crushed. These accidents can be prevented by providing the machine, as in this exhibit, with a finger plate so arranged that should the worker's hand approach the " nip," the hand will raise the plate upward and set in motion a device which automatically reverses the motion of the roll and table and so removes the worker's fingers from the danger zone.

An example of another method is shown by the fixed guard plate which is fitted at the back of the roll in this exhibit, and can be used also at the front. The guard plate is so adjusted that it is impossible for the worker's hand to reach the " nip " of the roller.

*Fixed guard lent by*—ISAAC BRAITHWAITE & SON, ENGINEERS, Ltd., Kendal.

## Finger Guard for Ironing Machine.

*Lent by*—MANLOVE, ALLIOTT & Co., Nottingham.

## Ironing Table.

The feature of this exhibit is the arrangement for standing the irons when not in use. Usually, the stand on which the irons are put is raised an inch or so above the level of the ironing table. Little as is the height

of the stand, the weight of the irons (many of them from 8 to 10 lb., some of them even a good deal more), and the number of times the iron has to be put on the stand (often 220–240 times an hour), combined with the heat of the irons, makes hand ironing hot and exhausting work.

In this exhibit, the stand, which consists of a zinc sheet screwed down upon asbestos sheeting, is made flush with the covering of the part of the table on which the ironing is done, so that the irons may be *slid* (without lifting), direct from the articles being ironed, on to the stand. The zinc sheet is suitably divided into lengths and the screw holes are elongated in order that expansion will take place without buckling.

Attention is called to the seat fixed to the ironing table. The fact that ironing has to be done standing is an additional cause of fatigue and it is desirable in the interests both of the welfare of the worker and her efficiency that when opportunities occur for sitting (as they do from time to time while she is waiting for work), she should be able to take advantage of them. The provision of such seats is now made obligatory by a Welfare Order under the Factory Act.

*Seat supplied by*—JAS. GIBBONS, Ltd., Wolverhampton.

## Gas Iron.

Imperfect combustion in a gas iron results in the emission of noxious fumes which may contaminate the air of the workroom. Also in high pressure gas irons faulty design of the " bunsen " tube causes considerable noise. The attention to detail in the iron shown in this exhibit has ensured good and silent combustion. The air inlet is of sufficient size to allow of proper mixture of gas and air ; the protecting gauze to the inlet acts as a filter and keeps fluff out of the " bunsen," which might otherwise choke the tube and impede the gas supply. The tap is designed so that it cannot work too stiff or too loose, the plug of the tap being held in its seating by a spring, and escape of gas at the tap is rendered less possible. A porcelain insulator is also interposed on the tube to prevent the transference of heat to the flexible tube. The opening for lighting the iron is covered by a hinged flap which is always closed when the iron is in use, and thus prevents the flame coming out and damaging the work.

*Lent by*—THE SOUTH METROPOLITAN GAS Co., Ltd., Old Kent Road, S.E.

## Electric Iron with Reyrolle Connector.

The special features of this electric iron which render it exceptionally suitable for industrial use are (1) that for the usual removable connector is substituted a fixed circular plug connector, of which the lower part is

rigidly riveted and screwed to the metal work of the iron case, and the top part, though removable, is normally secured in position by a milled ring; (2) that the flexible cable is brought out at an angle which keeps it well clear of the operator's wrist; and (3) that the wiring at the point of entry is further protected by a flexible metal tube. This construction eliminates the risk of burns from short circuits of the flexible close to the user's hand due to the perishing of the insulation from overheating or from the continuous movement of the iron. The cable is three-cored, so as to provide proper earthing.

Many ironers make a habit of holding the iron close to their faces to test the temperature. Should the iron turn on the wooden handle or slip in the hand, the face or wrist may be burned. The provision of the thumb-rest prevents this rather common form of accident.

*Lent by*—
SIEMENS BROTHERS & Co., Ltd., Woolwich, S.E.18.
A. REYROLLE & Co., Hebburn-on-Tyne.

## Electric Irons.

In one of the exhibits the connection box is ventilated and is of metal bonded to the metal work of the iron. The plug for attachment to the flexible conductor is provided with a spiral spring, through which a 3-core flexible conductor passes. A metal spring tongue fixed to the plug is connected to the earth wire, and, when inserted into the socket of the iron, makes contact with the connection box.

*Lent by*—SIEMENS BROTHERS & Co., Ltd., Woolwich, S.E.18.

A similar, but heavier, iron is also shown.

*Lent by*—THE GENERAL ELECTRIC Co., Ltd., Magnet House, Kingsway, W.C.2.

# PRINTING MACHINERY.

The platen printing machine is a fruitful—probably the most fruitful—source of accidents in the printing trades. The accidents are caused by the hand of the operator who is feeding the machine being caught and crushed between the " forme " (the plate which contains the type) and the " platen " (the plate which carries the sheet to be printed).

Different types of platen machine are exhibited, showing different methods for the avoidance of these accidents.

## " Cropper " Platen Printing Machine.

Used for " jobbing " work, where the number of sheets, cards, etc., to be printed is comparatively small and each sheet is separately fed into and taken from the machine by hand. Speed about 1,000 sheets per hour. The machine is provided with a guard (actuated by a link motion) which rises and covers the opening between the " forme " and " platen " as the " platen " closes, and pushes and keeps the hand of the operator away from the point of danger. The arms of the fly-wheel are protected by a circular sheet of metal.

*Guard given by*—J. P. UDAL, B.Sc., 45, Upper Dean Street, Birmingham.

Another type of guard, and one more commonly used, is the " rise and fall " bar. This guard consists of a single bar which, like the other guard, rises as the platen closes. The effectiveness of this type of guard depends in part on the amount of " lift " of the bar. The bar should be made to rise at least 8 in. as the platen closes, but guards are frequently found where the lift is much less. With this type of guard it is not impossible for the operator to get his hand over the guard into the opening, and accidents in fact occur from time to time. This type of guard, therefore, is regarded as less efficient than the other.

## " Victoria " Platen Printing Machine.

This machine also is used for jobbing work, especially colour work where great accuracy of feeding is required, and is fed by hand. It is provided with a guard bar over the platen and if this is displaced (e.g., by the operator's hand) as the " platen " is closing a trip gear operates to stop the machine. The trip gear, in addition to disengaging the clutch, also applies a brake, thus rendering the stoppage practically instantaneous. The fly-wheel is of the plate pattern with small holes for pulling it round by hand when necessary, and the gears are entirely shrouded by strong side and peripheral guards.

## "Falcon" Gripper-Feed Platen Printing Machine.

In this machine, which is used both for "jobbing" work and for longer runs of work, and which has a speed of about 2,500 sheets per hour, the sheets are not fed directly on to the platen by the operator, but into a gripping attachment which automatically carries the sheet on to the platen. When printed, the sheet is again gripped by another attachment, and delivered automatically at the back of the machine. With this arrangement there is little or no risk of the operator's hand being caught between the "forme" and the "platen."

*Lent by*—WAITE & SAVILLE, Ltd., Otley, Yorks.

## Automatic-Feeder Platen Printing Machine.

In this type of machine, feeding by hand is eliminated, and the printing process is entirely automatic. The sheets to be printed are piled on the feed table, from which they are picked up one by one by suction, carried through the machine and delivered at the back. Speed about 4,000 sheets per hour. This machine is mainly used for long runs of work.

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## PHOTOGRAPHS.

Other methods of guarding printing machines are shown on Screen XXXV.

A method of removing the dangerous lead dust from type cases by means of a vacuum cleaner with a special nozzle is illustrated in the Ventilation Room.

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## Paper Cutting Guillotine.

A note on the machine and guards recently installed, prepared too late for inclusion here, will be found at the end of the volume as an Addendum (p. 205).

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# CARDBOARD BOX MACHINERY.

## Wire Stitching Machine.

This machine is used for joining cardboard and for staying or stiffening the corners of cardboard boxes. Plywood is sometimes used instead of or with cardboard.

The article to be jointed or box corner to be stiffened is placed on the "anvil" at the front of the machine. The wire for stitching, which is supplied from a reel at the back of the machine, is cut off and bent into an inverted U by the machine and retained, ready to form a stitch, in the "head" of the machine, which the operator controls by the foot pedal.

The operator's fingers may be caught and crushed between the "anvil" and the falling "head." Such accidents are particularly liable to occur whilst (1) cleaning the machine, (2) pulling out a bent or broken wire with the fingers, or (3) adjusting the machine whilst under power. The machine exhibited is designed to prevent such accidents as these by :—

(1) A "safety catch" which the operator can easily bring into action, which locks the pedal control so that the machine cannot be operated, accidentally or otherwise.

(2) A guard plate which, when the foot pedal is pressed, slides across the surface of the work to be stitched from back to front, thus pushing the operator's fingers out of the danger zone while the wire stitch is made. As the "head" returns upward, the guard moves again to the back.

*Lent by*—VICKERS-ARMSTRONGS, Ltd., Erith, Kent.

## Corner Stayer.

A machine for staying or stiffening the outside corners of cardboard boxes with a narrow strip of stiff adhesive paper. The corner of the box to be stiffened is placed on the "anvil" at the front of the machine. The paper is carried forward as a continuous strip from the reel at the back, being damped and shaped during its passage, and is pressed on the corner of the box and cut off by the fall of the "head," which the operator controls by the foot pedal.

Many accidents have occurred through the operator's fingers being caught and crushed between the "anvil" and the falling "head," whilst (*a*) cleaning the "anvil," or (*b*) pulling a piece of broken paper through the machine from the front instead of pushing it from the back, or (*c*) making

other adjustments whilst the machine is under power. To prevent such accidents the machine exhibited is provided with :—

(1) A " safety catch " which the operator can bring into action without leaving his or her seat ; the safety catch is connected with the starting lever and when in the " stop " position the machine cannot be started, accidentally or otherwise.

(2) Two " push plate " guards, which are attached to the part of the machine carrying the adhesive paper forward and which by sweeping along the " anvil " will push the operator's fingers out of the danger zone before the " head " descends on to the " anvil."

*Lent by*—VICKERS-ARMSTRONGS, Ltd., Erith, Kent.

*Model lent by*—W. SISSON & Co., Ltd., Elmbridge Road, Gloucester.

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## PHOTOGRAPHS

Other types of guards for cardboard box machinery are shown in the album.

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## POWER-DRIVEN SEWING MACHINES.

The main danger-point here is the underbench shafting. Workers have been partially or wholly scalped by coming into contact with the shafting as they reached or dived under the bench to pick up a reel of cotton or other article which they had dropped.

These accidents can be prevented either by :—

(1) The complete enclosure of the shaft by a sleeve ; or

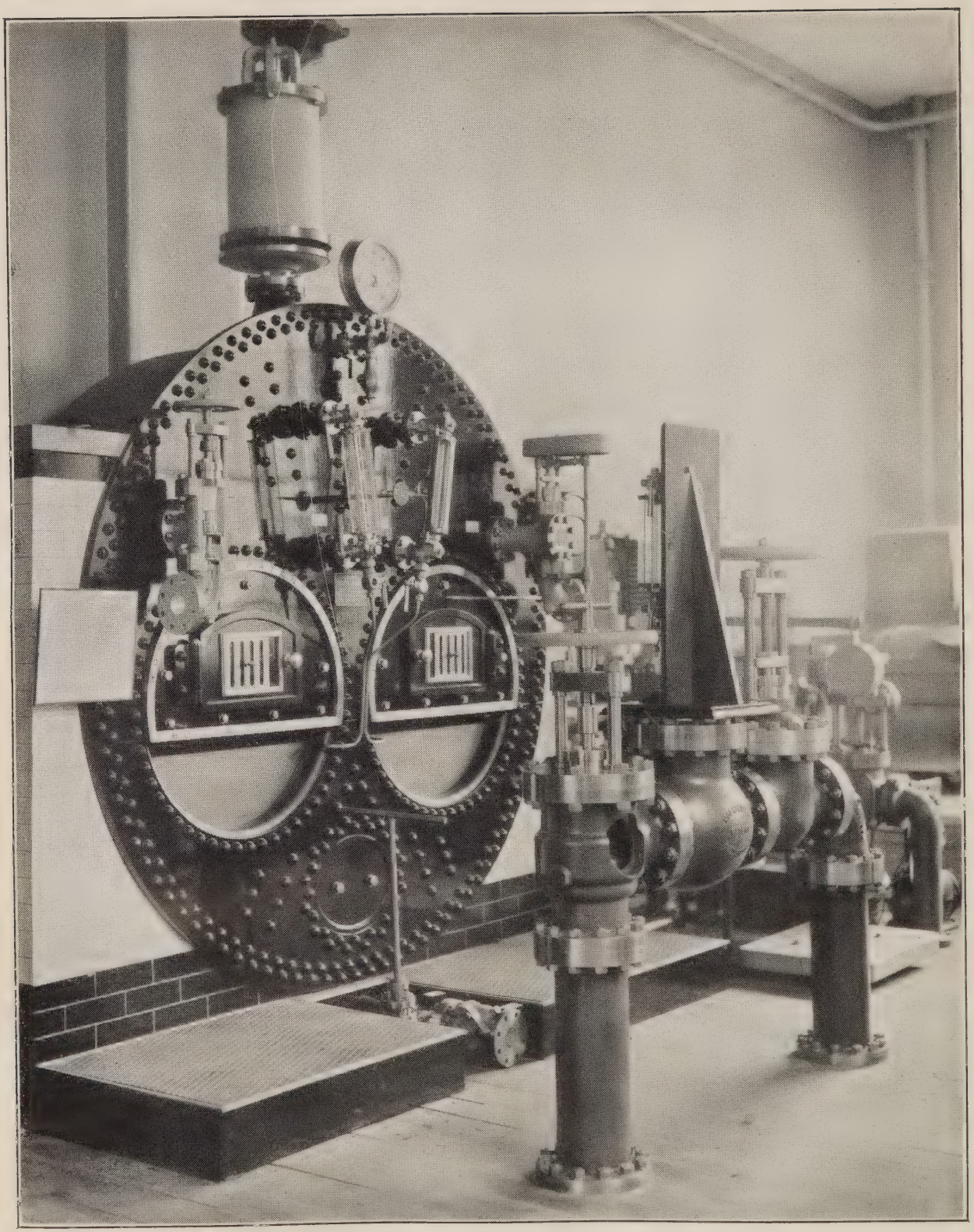
(2) The fencing of the shaft by means of—

(*a*) Bars placed not more than 6 in. apart, and

(*b*) A stout wire screen at the end of the bench.

Both methods are shown in the exhibit.

*To face p. 59.*



BOILER FRONT AND OTHER STEAM PLANT.

Many minor accidents have also been caused by the worker's finger getting under the needle, which may make approximately 3,000 to 3,500 stitches per minute. Such accidents are liable to occur not only when the machine is actually running, but also through the worker inadvertently depressing the starting pedal of the machine when she is re-threading the needle. One of the machines is fitted with an interlocking needle guard to prevent accidents of this kind. It is devised so that (1) until the guard is shut and locked the needle cannot be operated, and (2) the guard cannot be opened until the machine is stopped. There are other types of guard (also shown in the exhibit) which reduce but do not so fully eliminate the risk. Such guards are very liable to be pushed out of place by workers who have not been accustomed to them. An additional precaution, shown in the exhibit, is to throw a light directly on the needle by means of a small electric lamp specially fixed for that purpose.

*Lent by*—SINGER SEWING MACHINE Co., Ltd.
*Interlocking guard lent by*—A. WALLIS, 6, Swan Yard, Islington, N.1.

*Needle guards lent by*—
J. PECK & Co., Ltd., Edge Lane, Liverpool.
W. & J. BOGOD & Co., Ltd., Newport Road, Cardiff.

*Individual lighting for sewing machines lent by*—
TOOTAL BROADHURST LEE Co., Ltd., Bolton.

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## STEAM BOILERS AND STEAM FITTINGS.

Steam boilers and steam fittings in ordinary industrial use are subjected to steam pressures which vary from a few pounds to about 350 lb. per square inch. Failure of any part of the plant to withstand the pressure may result in a serious explosion.

The principal causes of explosions are :—

(*a*) working at an excessive pressure ;
(*b*) defects in design or workmanship ;
(*c*) defective material ;
(*d*) stresses set up by water-hammer action ;
(*e*) wasting of the material through corrosion, grooving and pitting of the plates or tubes ; and
(*f*) user's ignorance or neglect to keep the plant in proper condition.

As safeguards against these dangers, the law requires the provision and maintenance of (*a*) a safety or relief valve, (*b*) a steam gauge to indicate the pressure of the steam, and (*c*) a water gauge to show the height of water in the vessel. It also requires that the boiler and fittings shall be thoroughly and regularly examined by a person fully competent for the purpose. The essentials of a thorough examination are stated in the Factory Department Form (No. 55) which is exhibited.

The Home Office statistics show that the failure of steam plant still causes many accidents and indicate the necessity of constant watchfulness to ensure the maintenance of such plant in proper working condition :—

| *Period.* | *Number of Explosions.* | *Deaths* | *Injuries.* | *Total.* |
|---|---|---|---|---|
| 1920–26 .. .. | 196 | 55 | 189 | 244 |
| 1927–32 .. .. | 268 | 29 | 216 | 245 |

The exhibit includes the front plate (full-size model) of a steam boiler (Lancashire type) to which are attached the several fittings required by Statute : also various other types of steam fittings and appliances. Many of the exhibits are partially sectioned so that the internal parts may be seen. The exhibits are described in detail in the separate notices.

*Safety Valves.*—There are three main types of safety valve :—(1) Dead weight, (2) spring, and (3) weighted lever. The overloading of safety valves or other interference with them by unauthorised persons is sometimes a cause of boiler explosions, and is illegal. To prevent it, locked covers can be fitted on the dead weight and spring types. With the lever type it is not so easily prevented ; the risk can be minimised by cutting the lever to the correct length, but it is good practice on a boiler fitted with a lever safety valve to provide a locked safety valve as an additional safeguard.

*Pressure Gauge Testers.*—The pressures indicated on the Bourdon type gauges are frequently found to be faulty, owing to various causes, and in view of the great importance of indicating accurately the pressure

to which a vessel is subjected the gauges should be checked periodically. A set of appliances for testing pressure gauges is shown. For details and methods of use see notice.

*Reducing Valves.*—Plant intended to work under low pressure steam, such as drying cylinders, boiling pans, hot plates, has in many cases been connected to pipes containing steam at much higher pressure through an ordinary stop valve, and it has been left to the judgment of the attendant to open the valve just sufficiently to allow the desired degree of pressure to be reached. Under such conditions, with no safety valve, or a safety valve of inadequate size, on the plant, an explosion has sooner or later occurred. The danger can be completely obviated by the use of (1) a reducing valve which automatically regulates the pressure of the steam admitted, and (2) a proper safety valve on the low pressure side. The exhibits are of several different designs.

*Steam Traps.*—A steam trap is an automatic appliance which allows water of condensation to escape from pipes, etc., in which steam pressure exists, without letting out an appreciable quantity of the steam ; it thus serves as a safeguard against the fracture of the pipes, etc., by " water hammer." Such traps are fitted to ranges of steam piping, drying cylinders, boiling pans, hot plates, etc. Three types of trap are exhibited, named respectively, (1) Float, (2) Bucket, and (3) Expansion, according as the main valve that liberates the water is operated by (1) a " float," (2) a " bucket," or (3) a device the action of which depends on the difference in the expansion of two different metals. There are many variations in detail of design in each group. In the exhibits of type (1) the valve controls the *inlet* of water and steam into the trap, while the outlet is free, so that the steam pressure in the trap is always small. In the exhibits of type (2) the valve controls the outlet : the body of the trap is consequently subject to the full pressure of the steam system to which it is connected, and is designed to resist that pressure. The pressure enables the water to be discharged at considerable heights—these are called " lifting " traps. Low pressure steam systems, where no appreciable lift of the water is required, are often equipped with a trap of type (1). Types (2) and (3) are more frequently used on high pressure systems.

*Stop Motions* (which have been extensively used for many years in connection with steam engines in textile mills, particularly in Lancashire and Yorkshire) are devices by means of which in certain emergencies the main valve admitting steam to the engine is closed and the engine is quickly stopped. The details of the arrangements of the valve-closing springs differ in the two valves exhibited.

" Stop Motion " installations usually provide for :—

(*a*) " Remote control " (voluntary) by press buttons or " break-the-glass " switches.

(*b*) " Automatic control," which may be near or " remote " by—

(i) Frayed driving rope knocking out stick and releasing switch, or

(ii) By governor switch for overspeed.

Specimens of parts that have failed and caused explosions are also shown.

*Reference :—*

Memorandum on steam boilers by W. Buchan, 1912, published by H.M. Stationery Office.

*Exhibits contributed by :—*

(a) *Steam boiler front complete with attachments.*
(b) *Stop valves (2 types) and isolating valve.*
(c) *Safety valves in section.*
(d) *Safety valves (combined) for high pressure steam and low water.*
(e) *High and low water alarm.*
HOPKINSONS, Ltd., Huddersfield.

*Steam traps of different types—*
HOPKINSONS, Ltd., Huddersfield.
LANCASTER & TONGE, Ltd., Pendleton.
ROYLES, Ltd., Irlam, nr. Manchester.
Sir W. H. BAILEY & Co., Ltd., Salford.

*Reducing Valves—*
HOPKINSONS, Ltd., Huddersfield.
ROYLES, Ltd., Irlam, nr. Manchester.

*Boiler water gauge glass and protector—*
SMITH BROS. & Co. (HYSON), Ltd., Nottingham.

*Safety Valves—*
COCKBURNS, Ltd., Cardonald, Glasgow.
BUTLER & SONS (B. & S. VALVES), Ltd., Dukinfield, Manchester.
VULCAN BOILER & GENERAL INSURANCE Co., Ltd., Manchester.
BRITISH COTTON & WOOL DYERS ASSOCIATION, Ltd., Manchester.

*Engine Stop Motions—*
JAMES TATE & Co., East Parade, Bradford.

*Interlocking device for manhole cover, and feed water and steam valves for boiler—*
JOHN SUMMERS & SONS, Ltd., Shotton, Chester.

*Stop-cock with safe means of easing from seating—*
AUDLEY ENGINEERING Co., Newport, Salop.

*Pressure gauge tester—*
VULCAN BOILER & GENERAL INSURANCE Co., Ltd., Manchester.

*Flexible steam pipes—*
W. H. DORMAN & Co., Ltd., Stafford.

*Fusible plugs—*
VULCAN BOILER & GENERAL INSURANCE Co., Ltd., Manchester.

# HOISTS.

## Electric Lift for Passengers or Goods.

The lift, which serves three floors—basement, ground floor and gallery —is intended also as an exhibit to illustrate the fencing and other arrange ments required for safety. The cage, which is constructed with steel framing and metal sides and top, and has a lifting capacity of 1 ton at a speed of 100 ft. per minute, is suspended by means of four flattened-strand steel wire ropes of $\frac{5}{8}$ in. diameter. These ropes are attached, by means of properly spliced eyes with thimbles, to the arresting or safety gear which is fitted below the cage, and to the balance-weight by means of eyes secured with three grippers on each rope. The driving mechanism which is installed in a housing on the roof of the building consists of a 16 h.p. motor operating a drum through a worm reduction gear with a gear ratio of 65 to 1.

The following are the principal safety features :—

*Lift Shaft.*—This is fenced fully on the front, and on the sides to a height of 9 ft. above each floor, by means of wire meshing. The landing openings are fitted with collapsible gates which are electrically and mechanically interlocked so that (*a*) all the landing gates must be properly closed before the cage can be moved ; and (*b*) no landing gate can be opened unless the cage is at that landing. The interlocking is effected as follows :—The " beak " on the gate entering the lock operates a switch in the electrical control circuit so that the motor cannot be energised until all the gates are properly closed. When the cage moves away, the crank with the roller falls and mechanically locks the gate.

The gates are of the centre or mid-bar type, as the mid-bar affords additional safety by reducing the spacing when the gate is extended and rendering it impossible for a person to reach through the gate to a dangerous extent. The mid-bars extend to the bottom track, thus preventing a person standing near the gate from putting his foot between the bars and getting it trapped by the moving cage.

A space 3 ft. in depth is left below the cage when at the bottom of its travel. This minimises the risk of a crushing accident to a person working in the shaft below the cage.

*Control.*—The cage is controlled either by means of a car switch or by automatic push buttons. A change-over switch is fitted outside the lift for effecting the change from one system to the other. Each landing call button operates two push movements simultaneously, one to call the lift when on " push button " control, and

the other to ring the bell of a floor indicator in the cage when on " car switch " control. When the latter is in use, the " call " push circuit is broken and only the bell rings. This system prevents confusion, which often arises when separate pushes are used through the caller not knowing if the lift attendant is on duty. When the lift is under " car switch " control, all push buttons are inoperative and the attendant has entire control from the cage. On the other hand, when the lift is used on " push button " control, the occupant of the cage has sole control ; the landing call buttons being rendered inoperative by the depression of the spring floor switch in the cage.

*Cage.*—The cage opening is fitted with an interlocking mid-bar collapsible gate similar to those fitted on the landing openings and the cage cannot be moved before this gate is closed.

Rope safety gear is fitted under the cage ; this consists of four serrated cams which engage with the wood backings of the cage guides in the event of either of the lifting ropes breaking or becoming unduly stretched. These cams are capable of supporting the cage and load. A safety switch is fitted to this rope safety gear in order to stop the motor when the cams engage, thus preventing the drum overwinding.

A slack rope switch is also fitted and actuated by a small rope fixed between cage and balance-weight to stop the motor and prevent overwinding in the event of either cage or balance-weight becoming lodged or jammed in the shaft.

A centrifugal tripping gear is fitted and connected to the safety gear under the cage so as to operate in the event of the cage attaining an excessive speed from any cause. This tripping gear is set so as to operate the safety gear when the speed reaches 20 per cent. over the normal.

*Over-running Device.*—An ultimate or main limit switch is fitted which breaks both poles of the main current supply in the event of the cage over-running the floor level at the top or bottom. This device is actuated by a " striker " on the cage engaging with " stops " on the continuous steel line. A separate contact fitted to open the brake circuit independently ensures that the brake is fully applied and not held off by regenerated motor current.

*Driving Mechanism.*—To prevent unauthorised persons approaching the mechanism while it is in motion, or any electrical parts which are live, the mechanism is shut off by a collapsible gate which is kept locked.

*Lift overhauled and new equipment supplied by—*
MEDWAY'S SAFETY LIFT Co., London.

*IN BASEMENT.*

## Electro-Mechanical Interlocking Arrangements for Hoists.

This exhibit shows types of interlocking arrangements which are suitable for, and can be fitted to, any hoist controlled by a rope, chain or car controller.

One arrangement consists of a "gripper" (fixed in a suitable position on the cage or elsewhere), which is always in mechanical contact with the control rope or chain. The "gripper" is provided with an electrical solenoid, which, when energised, allows the control rope to pass through it freely. The solenoid is electrically interconnected with the electro-mechanical locks on all the landing and cage gates or doors, and unless these are all shut the electrical circuit to the "gripper" will not be completed; the "gripper" would then not be energised, i.e., the control rope is held fast and the cage cannot be moved.

In this exhibit the "gripper" is interconnected with (*a*) and (*b*) the two gates and (*c*) the double door; if any of these are opened the control chain is locked.

*Lent by*—WADSWORTH & Co., Ltd., Bolton.

Other arrangements are fully described on notices attached.

*Lent by*—NEWBURY & THOMAS, 66, Westminster Bridge Road, London.
*Lent by*—A. BENNETT & Co., Ltd., Cobden Street, Pendleton, Manchester.
*Lent by*—WAYGOOD-OTIS, Ltd., 54-55, Fetter Lane, E.C.

There are many suitable types of interlocking arrangements on the market affording protection of this kind; for further information, *see* Home Office Safety Pamphlet No. 2, "Protection of Hoists."

## Collapsible Hoist Gates.

The ordinary form of collapsible gate has wide pickets in order to reduce the weight and make it easy to handle. The openings between the pickets are usually $4\frac{1}{2}$ to 6 in. in width, so that the foot of a person standing in the cage, or on the landing, may pass through the pickets, and the toes or heels may be severely injured by being caught between the edges of the cage and the landing.

The type of gate shown has been specially designed to prevent this class of accident, and, although the distance between the pickets is small, the gate can be moved easily by hand.

*Lent by*—WAYGOOD-OTIS, Ltd., 54-55, Fetter Lane, E.C.4.

## PHOTOGRAPHS.

Photographs of teagle guard, device to prevent overwinding on electric overhead travelling crane and bad design of hoist mechanism are shown on wall screen adjoining hoist on ground floor.

*GROUND FLOOR*—(continued).

## WOODWORKING MACHINERY.

1. *Safety.*—The Woodworking Industry is one of the most prolific in accidents. In the three years 1930–32, the total number of reported accidents on woodworking machinery was 8,581, of which 17 were fatal. As the general provisions in the Factory Act for the safeguarding of dangerous machinery proved inadequate to deal with the dangers, it was considered necessary to lay down in detail the precautions required, and Regulations for this purpose were made in 1922, and came into force on 1st January, 1923.

2. *Dust Removal.*—A large quantity of dust and chips is necessarily produced in woodworking processes, and for the reasons set out below the best practice is to collect the dust and chips by means of an exhaust ventilation system.

The woodworking exhibit includes types of the most dangerous machines in general use ; the guards and other precautions required in order to conform with the Regulations ; and an installation for drawing off by exhaust draught the dust produced.

The types of machine shown are :—Plain circular saw bench, roller-feed circular saw bench, two spindle dimension saw bench, pendulum cross-cutting saw, band sawing machine, overhand planing machine, two vertical spindle moulding machines, combined vertical chain and drill-spindle mortising machine.

A detailed description is shown with each machine.

*References* :—

Home Office Safety Pamphlet No. 8, " Fencing and other Safety Precautions for Woodworking Machinery " ; Home Office Regulations for Woodworking Machinery, 1922—both published by H.M. Stationery Office.

### Wood Dust and Chip Collecting System for Woodworking Machinery.

Most modern sawmills and woodworking plants are fitted with an " exhaust " system for removing the dust and chips as they are given off by the various machines. The use of such a system has the following advantages :—

(1) Reduces the amount of dust inhaled by the workers.

(2) Secures additional general ventilation of the workrooms.

(3) Keeps the machine benches and floors clear of dust and chips and so reduces the risk of accident to the workers, as well as cost of cleaning.

(4) Increases the output as the operator has not to lose time in clearing chokes caused by the wood refuse.

(5) Greatly diminishes the fire risk.

(6) Collects waste which is valuable fuel for boilers, producers, etc.

A system of this kind is installed in the woodworking exhibit. Each of the eight machines comprised in the exhibit is fitted with a hood of galvanised sheet metal, the form of hood being determined in each case by the construction of the machine and the cutting tool used. The hoods of the *Circular Saws* working in benches are fitted below the benches and thus also act as guards for the lower parts of the saws. On the *Chain Mortising Machine* the hood and duct are arranged so as to move up and down with the cutters. The hood on one *Vertical Spindle Moulding Machine* is made to be readily detachable so that a clear bench top can be obtained when necessary for moulding large articles. The blade of the *Band-Saw* passes through the hood and carries the dust into it.

For keeping the floor clear, a " sweep-down " hood is provided underneath it, with an opening in the floor fitted with a hinged cover. When the cover is opened, dust and chips swept near the opening are at once removed by the powerful exhaust draught.

Each hood is connected by means of ducts to an exhaust fan on the floor below, which draws the dust and chips along the ducts and discharges them into a cyclone collector outside the building. Dampers or blast gates are provided in the branch ducts to shut off the draught when necessary.

Separate notices describing the system of ducts, the fan and the cyclone collector will be found in the " Ventilation " Section in the Basement.

## Plain Band Saw.

Accidents on this type of machine are due to one or other of the following causes :—

(1) contact with the saw band ;
(2) slipping into the revolving spokes of pulleys ;
(3) breaking of the saw band.

The guards shown are designed to conform with the Regulations (Reg. 12) and to prevent, as far as possible, accidents due to the above causes. The pulleys are of the disc type, thus eliminating the danger involved with the spoked pattern, and, in addition, stout expanded metal guards are

fitted to protect the running saw band. An adjustable guard fitted to and moving with the band guide protects the portion of the blade in front of the operator's head, whilst the metal side guards near the top pulley prevent the band from flying off in the event of its breaking. It should be noted that the only exposed portion of the saw band is that between the top guide and the bench table.

The sawdust is drawn away, as far as possible, through the slot in the table into a sheet metal casing fitted below the table and connected by a branch duct to the main exhaust.

## Circular Saw (Plain Bench).

Circular saws have been responsible for very many accidents. These arise mainly in the four following ways :—

(1) Accidental contact with the front cutting edge of the saw.
(2) Contact with the back and top of the saw.
(3) Timber being thrown violently against the operator owing to the wood closing as it is being cut and gripping the back of the saw.
(4) Contact with the lower portion of the circular saw beneath the bench.

The following points should be noticed :—

(1) Easy accessibility of handle controlling striking gear lever.
(2) Top guard with deep flange extending below the roots of the teeth of the saw.
(3) Rigid and easily adjustable riving knife with front edge forming the arc of a circle and fixed less than half an inch from saw teeth at bench level.
(4) Easily adjustable sliding front guard.
(5) Simplicity of adjustment of whole guard unit by means of handle and screw on vertical support.
(6) The use of push sticks and push blocks.
(7) Protection of the lower portion of the circular saw obtained by a sheet metal casing fitted below the bench. The sawdust is drawn away through this casing which is connected by a branch duct to the main exhaust.

*Bench lent by—*
J. SAGAR & Co., Ltd., Halifax.
*Guard lent by—*
M. GLOVER & Co., Leeds.

## Circular Saw Bench—with Radial Arm Roller-Feed.

This type of bench is used for deep cutting and re-sawing deals, planks, etc., and illustrates the radial arm mechanical roller-feed. With such a feed the risk of contact with the front cutting edge of the circular saw is greatly diminished. The geared drive of the feeding mechanism is totally enclosed and the radial arm is adjustable so that different sizes of saws can be used. The toothed feed roller at the end of the radial arm is held against the timber by means of a counter-balance. The circular saw guards shown here are of the same type as fitted to the plain circular saw bench.

The sawdust is drawn away through a sheet metal casing fitted below the bench and connected by a branch duct to the main exhaust.

*Guard lent by*—J. SAGAR & Co., Ltd., Halifax.

### PHOTOGRAPHS.

Guards for log and rack saw benches are shown on the wall screen.

## Two Spindle Dimension Saw Bench.

This machine is a combined ripping and cross-cutting saw bench used principally in cabinet making and pattern making. A riving knife is fitted to each saw and is bolted firmly to the circular disc which carries the saw spindles. Each knife rises automatically with its saw into the correct working position. The saw in immediate use is protected by a double flanged guard which automatically rises and falls to suit the thickness of the wood. The guard is supported in such a way as to give ample clearance when cross-cutting is being done. The portions of the saws below the bench are protected by a hinged door and by the exhaust ventilation hood.

*Machine and Guard lent by*—
THOMAS WHITE, Ltd., Paisley.

*Guard lent by*—
A. RANSOME & Co., Ltd., Newark-on-Trent.

## Circular Saw Bench Model with Mechanical Pusher.

This type of bench is used for general purposes in woodworking shops. The " pusher " reduces the risk of contact with the front cutting edge of the saw. The riving knife and saw guard fitted to this bench are quickly adjustable to the varying dimensions of the wood, and the front of the guard can be opened to facilitate the sharpening or changing of the saw.

*Lent by*—W. & L. COLE, Ltd., Clinton Road, Mile End, E.

## Pendulum Circular Saw.

This type of circular saw differs from the ordinary type inasmuch as the saw moves towards the wood instead of the wood being pushed up to the saw. The machine is suspended from overhead hangers, and is pulled forward with one hand by means of the handle provided. whilst the timber is steadied against a stop with the other hand.

The guard consists of a complete cover for the top part of the saw, forming an integral part of the machine and leaving only sufficient exposure of the saw during the cutting operation to enable the cut to be made. In view of the close proximity of the driving belt and pulley to the operator in the forward position a guard, as here shown, is necessary for this portion of the drive. Where, as in the exhibit, the pendulum saw is placed against the wall there is no exposure to danger at the back, but where such apparatus is capable of being approached from the rear complete enclosure on that side is necessary.

Split pins in the ends of the balance weight guides prevent the weights falling off and injuring the worker.

*Lent by*—A. RANSOME & Co., Ltd., Newark-on-Trent.

### PHOTOGRAPHS.

Other methods of guarding pendulum saws are shown on the adjacent wall screen. A treadle-operated pendulum saw and guard are also shown.

## Overhand Planing Machine.

A machine used for producing a smooth surface on timber. The timber is passed by hand over a block, fitted with cutter knives, which rotates at approximately 4,000 revolutions per minute. Such machines were originally provided with the square type of cutter block (a specimen of which is shown alongside this exhibit) and a large number of very serious accidents were caused through the use of this particular design of block. Its use on overhand planing machines which are not mechanically fed is now absolutely prohibited by the Regulations (Reg. 13).

The safety type of cylindrical cutter block is shown fitted to this machine, and also two types of bridge guards with vertical and horizontal adjustments to conform with the Regulations (Reg. 15). The serious accidents involving the amputation of fingers and hands which used to occur with the square type of block have been eliminated by the use of the cylindrical block ; and by a careful adjustment of the bridge guards, the less serious accidents which might be caused by contact with the knives of the cylindrical block can be very largely avoided.

The wood-shavings are drawn away through a sheet metal casing fitted directly below the cutter block and connected by a branch duct to the main exhaust. This also obviates choking of the cutters and conduces to the efficient working of the machine.

*Guards lent by—*

J. SAGAR & Co., Ltd., Halifax.
A. COOKSLEY, 21, Tabernacle Street, London, E.C.
SOUTH METROPOLITAN GAS CO.

## Vertical Spindle Moulding Machine.

This machine is used for forming straight and curved mouldings on timber, and by means of special cutters and apparatus can be utilised for cutting dovetails, tenons, rebating, grooving, etc. It is one of the most dangerous machines used in the woodworking industry and has in some districts received the name of " the butcher." Accidents chiefly occur through the hand slipping against the revolving cutters and are often serious, involving the loss of fingers.

Serious, and sometimes fatal, injuries may also be caused by a badly secured cutter flying and striking the operator or anyone in its line of flight. The greatest care is therefore necessary in setting up and fixing the tools.

Owing to the variety of work done on vertical spindle moulding machines it is not possible to devise a guard applicable to all operations. Several types of guards are exhibited and these are described below.

The wood chippings produced are drawn away, as far as possible, through a sheet metal hood placed above the table and connected to the main exhaust. The hood can be removed to permit a clear table when moulding operations have to be carried out on large articles.

There are three types of cutter blocks in general use on spindle moulding machines. The type used in the building and joinery trades is the square block to which the cutters are attached by bolts fitting into longitudinal slots. The French spindle which is largely used in the various furniture trades consists of a slotted cylinder into which the cutters and balance pieces are fitted, being held in position by a long set screw from the top of the spindle. The third type—the collar spindle—sometimes used for the lighter types of joinery work, is a screwed spindle with the cutters secured between two grooved collars.

The types of guard shown are :—

*Band Type (Penn-Farrell Patent).*

This guard is suitable for various types of curved and straight work such as are carried out in the furniture trades on collar or French spindles.

It consists essentially of a curved metal spring band carried from a vertical bracket, adjustment vertically being readily carried out by the handle and screw provided. The portion of the guard in front of the cutters carries a sheet metal plate, the upper edge of which is turned inwards to deflect chips away from the operator.

*Lent by*—C. BREWER, 209, City Road, London, E.C.1.

### *Swing Type (Howlett's Patent).*

This guard consists of two slotted metal plates capable of independent vertical adjustment by means of thumb screws carried on a swinging arm from a supporting bracket. This arm is held in the normal position by a strong spring and as the wood is pushed forward it moves the metal shield away from the cutters, whilst after the passage of the wood, or in the event of the timber slipping, the guard is immediately brought back by the action of the spring to its normal position covering the cutters.

It is suitable for both straight or curved work on the collar or French type of spindle when working without the vertical fence. For setting up the machine the whole guard is readily rotated in the vertical plane by slackening the hand screw on the vertical arm.

*Lent by*—A. HOWLETT, 29, Desborough Street, High Wycombe.

### *Shield Type.*

The guard shown here is suitable for straight work such as occurs in the joinery trade when the square cutter block is in use, and a vertical fence provided. It is arranged for horizontal adjustment by means of slots in the bench table, the whole guard being moved by sliding the supporting bracket, whilst vertical adjustment is rendered simple by the provision of a slot and thumb screw on the shield member. By these means it is possible to pass timber between the shield and the fence or by raising the shield to pass it underneath. The guard is hinged at the end of the horizontal bracket arm so as to simplify setting up.

*Lent by*—J. SAGAR & Co., Ltd., Halifax.

### *"Shaw's" Spring Type Guard.*

This guard is applicable when straight work is being moulded and the fence in use. It consists of a bracket carrying two strong metal springs on which blocks of wood are mounted. The work is pushed between the vertical and the horizontal members which grip the work and prevent the hand slipping on to the revolving cutters.

*Lent by*—A. COOKSLEY, 21, Tabernacle Street, London, E.C.

*Revolving Type (Money's Patent).*

This type of guard is only applicable to the French pattern of spindle and consists of a cage with the upper portion constituting a spring shank, which allows the guard to be slipped on and off the spindle easily and quickly, and revolving with it. The lower edge of the cage is adjusted slightly above the cutters and a guard is chosen of such diameter that its periphery projects beyond the cutters. Since various types of cutters of different sizes are frequently used, a set of guards of graduated diameters is generally necessary. This type of guard has the advantage of extreme simplicity.

*Lent by*—C. BREWER, 209, City Road, London, E.C.1.

*Ring Type (Yarwood Patent).*

This guard consists of two slotted plates, capable of independent horizontal adjustment, carried on the ring from a supporting bracket. The first plate is adjusted so that the work will just slide under it, and the second is purposely fixed about a quarter of an inch lower than the first. Since the latter plate is " toothed " and hinged and is pushed out of the vertical by the work, it acts as a wedge and prevents a " kick back " of the work.

This guard is used for both circular and straight work.

A wood slipper is provided to press the work on to the bench, and for small work this slipper is replaced by a small hinged attachment which acts in the same manner as the second plate above.

*Lent by*—A. E. YARWOOD, 42, Studley Road, Darnall, Sheffield.

*Universal Spindle Moulder Guard.*

This type of guard, with accessories, is designed for all kinds of work on a spindle moulding machine.

*Guard presented by*—CAISSE NATIONALE SUISSE D'ASSURANCE EN CAS D'ACCIDENTS.

*Safety Chamfer Cutter.*

The knives are secured in a circular metal block, and should the operator's hand slip and come in contact with the cutter the injury is less serious than with the ordinary type of cutter.

*Safety cutter lent by*—CHAPLOW & SONS, Helsington Mills, Kendal.

## PHOTOGRAPHS.

Guards and jigs for spindle moulding machines are shown on the adjacent wall screen.

## Combined Vertical Chain and Hollow Chisel Mortising Machine.

This machine is used for mortising and recessing timber. The timber is placed on the adjustable table and clamped in position by means of a sliding quick-acting cramp with special rack and worm for final tightening. The chain-cutter and hollow chisel are arranged with automatic rise and fall motions controlled by the two hand levers on the right of the machine.

Accidents due to accidental contact with the rapidly moving cutters of the chain can be prevented by the provision of a fixed guard completely enclosing the top portion of the chain and a sliding lower portion which can be brought down on to the top surface of the timber being operated upon, thus completely guarding the front and side of the cutters in the working position. As the cutters enter the wood the telescopic sliding portion is automatically pushed upwards.

Other special safety features of this exhibit are :—

(1) Easy accessibility of the handle controlling the striking gear.
(2) Spring locking devices on the controlling handles.
(3) Complete enclosure of toothed gear wheels.
(4) Belts and pulleys are housed in the hollow machine framework.

The wood chippings produced are drawn away through the fixed guard enclosing the top of the chain, which acts as a hood and is connected by a telescopic branch duct to the main exhaust. The removal of the chips from the timber facilitates the work.

*Lent by*—JOHN PICKLES & SON, Hebburn-on-Tyne.

## Non-Slip Flooring.

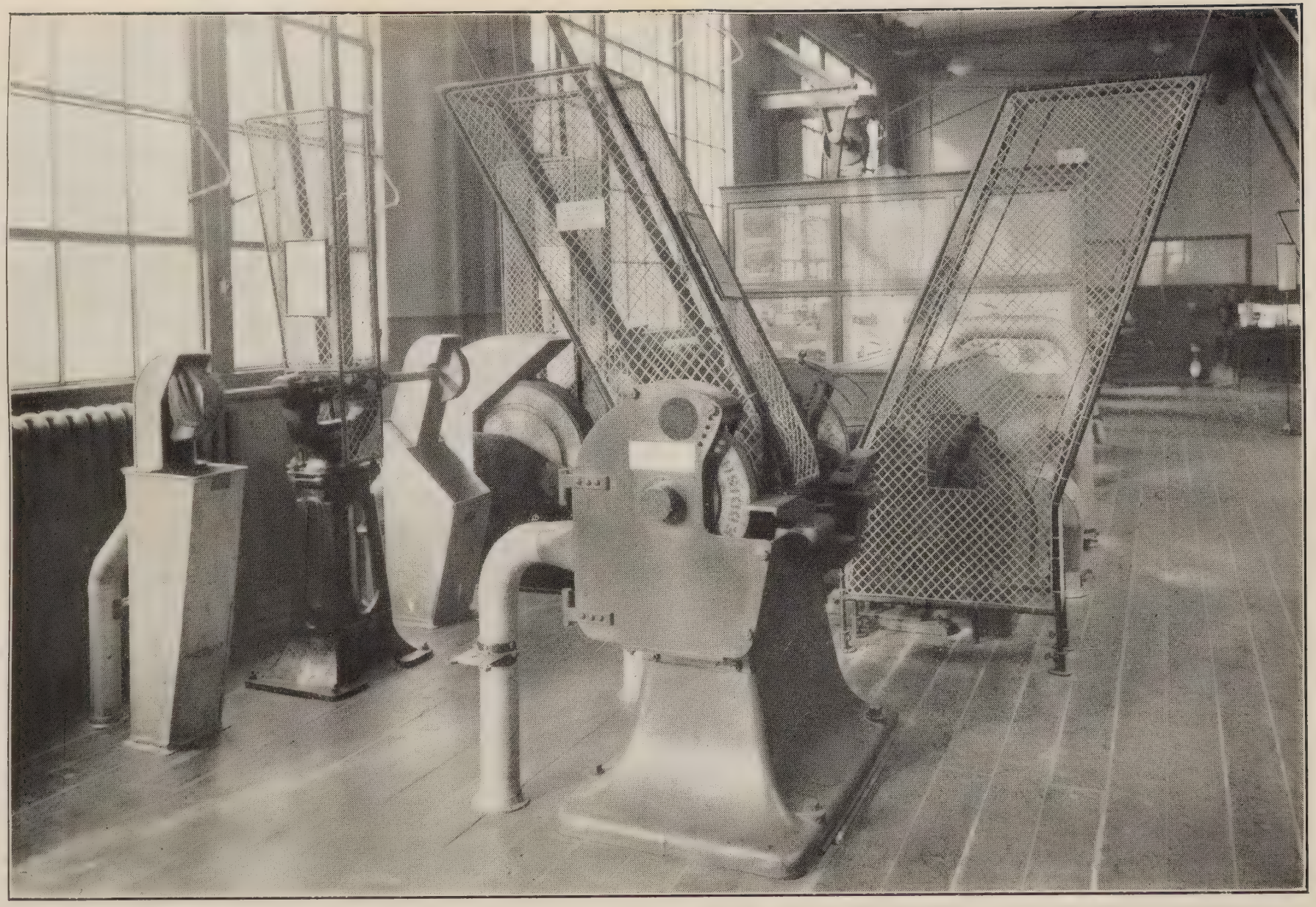
Slippery floors are a recognised source of danger and have given rise to many accidents, some of them with fatal results. The danger is intensified where high speed machinery is in operation. The risk may be largely reduced by the provision of a non-slip surface to the floor at the working position of the machine operator. Several types of non-slip surfaces are shown in the woodworking machinery section :—

(1) The portion of the floor on which the worker stands when operating the machine, is covered with a woven coarse cotton fabric, which is fixed to the floor and forms a suitable non-slip surface.

*Lent by*—FERODO, Ltd., London.

(2) The portion of the floor on which the worker stands when operating the machine, is covered with glue sprinkled with carborundum dust. This provides a cheap and suitable form of non-slip surface which can be readily renewed when required.

*To face p. 75.*



GRINDING SECTION.

Polishing and glazing machines (left) ; grinding machine with abrasive wheels (centre) ; rumbler (right).

(3) The portion of the floor on which the worker stands when operating the machine, is covered with tiles composed of artificial corundum, bonded together with special clay mixtures kiln hardened. The tiles when embedded on cement form a good wearing, even and suitable non-slip surface.

*Lent by*—B. R. ROWLAND & Co., Ltd., Climax Works, Reddish.

(4) This form of non-slip floor consists of a cast iron plate with a specially prepared rough surface. The plate is fixed to the floor with wood screws.

*Lent by*—BOWES-SCOTT & WESTERN, Ltd., Parliament Mansions, Victoria Street, S.W.1.

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## GRINDING WITH ABRASIVE WHEELS AND POLISHING OF METALS.

This exhibit includes a few types of machine used in the metal grinding industry :—

A Grinding Machine (with abrasive wheels).
Glazing and Polishing Machines.
A Tumbling Barrel or Rumbler.
A Buffing Machine.

The use of grinding wheels made of some artificial abrasive substance has in recent years superseded the natural grindstone in many sections of the industry, partly as the result of the new regulations under the Factory Act. While they are exempt from the special danger of silicosis which is incident to the use of the natural grindstone,

(*a*) the danger from the bursting of the wheels remains, and
(*b*) the inhalation by the workers of the dust evolved during the processes is definitely injurious.

The dust danger exists also in glazing and polishing processes.

(The special danger of silicosis incident to the grinding of metals on natural grindstones is dealt with in the Silicosis Exhibit in the Gallery).

*Accidents.*—Numerous accidents are caused by the bursting of grindstones and abrasive wheels. Twenty-five fatal and 688 non-fatal occurred during a period of seven years. They were mainly due to the stress set up by excessive speed. For all ordinary work on abrasive wheels, the peripheral speed of 5,500 ft. per minute cannot be exceeded with safety.

The following precautions are now required :—

(1) The safe working speed of each wheel must be exhibited in the workroom.

(2) The wheel must be protected by a strong guard, or where the nature of the work prevents the use of a guard, specially tapered wheels gripped by similarly tapered steel flanges must be adopted.

*Dust.*—The following precautions are now required :—

(1) local exhaust ventilation to carry away the dust as near as possible to the point of origin ;

(2) periodic cleaning of all parts of the room and fixtures.

For greater safety not more than one person is now allowed to work on the wheel or glazer at the same time.

*References* :—

Report on the Grinding of Metals and Cleaning of Castings (1923), by E. L. Macklin, O.B.E., and E. L. Middleton, M.D., D.P.H. ; Home Office Safety Pamphlet (No. 7) on the Use of Abrasive Wheels ; Home Office Regulations (1) for the Manufacture of Cutlery and Edge Tools, and (2) for the Grinding of Metals (Miscellaneous Industries). (Published by H.M. Stationery Office.)

# MACHINERY FOR GRINDING AND GLAZING OF METALS.

## Double-Ended Dry Grinding Machine.

The machine shown is principally employed for removing excrescences from castings, forgings and stampings. It may also be employed for grinding and sharpening tools, but in such cases it is generally used wet

The maximum safe peripheral speed for ordinary abrasive wheels used on this type of machine is 5,500 ft. per minute.

The guards for the wheels (*a*) must be strong enough to withstand the impact and to retain the broken pieces of a burst wheel and should accordingly be made of steel—cast-iron is not reliable ; (*b*) must be securely anchored ; and (*c*) must be adjustable so that proper enclosure

is maintained as the wheels become reduced by wear. The guards shown comply with these requirements and serve also as hoods to facilitate the removal of the dust by means of the fan acting on the dust exhaust system.

In some classes of grinding, e.g., internal grinding of stove grate fittings, the nature of the work precludes the use of guards. In such cases tapered wheels gripped by steel flanges of corresponding taper, known as protection flanges, should be adopted. One of the wheels on this machine is so fitted.

Other features of the exhibit are (*a*) proper adjustment of rests so that the operator's finger, or the part of the work being ground, is not trapped between the fixed rest and the revolving wheel; (*b*) protection of the projecting spindle-ends to prevent a person's clothing being caught; (*c*) efficient striking gear to secure control of the running of the machine; (*d*) spark guards to protect the worker from any incandescent particles which might escape the exhaust.

*Hood guards lent by*—B. R. ROWLAND & Co., Ltd., Reddish.
*Spark guard given by*—LONDON GENERAL OMNIBUS Co., Ltd., Chiswick, W.4.
*"Clear View" spark guard lent by*—J. BROUGHTON, Vere Street, Birmingham.

## Large Glazing Machine.

This machine is used for smoothing and polishing castings and forgings of considerable size after they have been roughly ground on grindstones or abrasive wheels. It is principally employed for polishing parts of textile machinery, stove-grates and locomotives.

The wheels are of wooden segments built up on a central core. Leather, walrus hide, or similar material, is fixed round the periphery, and the surface is coated with glue and emery or other abrasive substance. The first glazing operation is performed on a rough wheel, and a finer wheel, coated with an admixture of abrasive and grease, is used for the final polishing.

The peripheral speed of these glazers is from 6,000 to 7,000 ft. per minute.

It is not customary to guard these wheels as bursts are very rare; moreover, the nature of the work, which is mainly done upon the upper surface of the wheel, precludes the application of a guard.

The danger with this type of machine is the inhalation by the operator of the dust evolved. This may be almost completely prevented by proper exhaust ventilation, and one type of hood for this purpose is shown connected to the exhaust circuit. The hood must be easily adjustable so as to suit the size and shape of the work. As the distance

between the entry to the duct and the point of evolution of the dust may have to be considerable where awkwardly shaped articles are being dealt with, the air speed in the ducts should be not less than 3,000 ft. per minute. The belt-striking lever is notched to prevent creeping of the belt.

## Small Glazing and Polishing Machine.

This type of machine is very extensively used for the glazing, buffing, mopping, or polishing of all kinds of metal articles.

The " head " is usually made of a number of discs of textile material clamped together and coated on the peripheral surface with abrasive material. The abrasive may be emery, powdered pumice, rotten-stone, Tripoli, lime, or rouge, with or without admixture of grease, depending upon the degree of polish desired or the nature of the article treated. Sometimes the " head " is of wood or fibre, and circular brushes of hair or wire are also used. The " heads " are readily interchanged by means of the tapered threads on the spindle ends.

The inhalation of the dust evolved is the principal danger with this type of machine. Owing to the diversity, both as to size and shape, of the articles treated, the dust exhaust hoods require to be carefully designed. Two types of hood are shown, one for ordinary small work and the other for the mopping and polishing of awkwardly shaped articles.

Proper striking gear is necessary in order to control the machine, and belts should be fenced to a height sufficient to prevent the operator being injured by the belt fastenings.

## Tumbling Barrel, Rumbler or Rattle Box.

This machine consists of a revolving barrel in which castings are placed, together with pieces of metal (known as " stars," or " burrs,") or, sometimes, pebbles. The castings are freed from sand and smoothed by being rubbed against the other contents as the barrel revolves. A similar type of machine is also used for brightening stampings, in which case scraps of leather, sawdust, or other materials are used instead of pieces of metal.

A large amount of dust escapes from the barrel when castings are dealt with and also when the barrel is emptied. There are two methods of suppressing the dust ; one is to enclose the barrel in a housing and connect the enclosure to the dust exhaust system ; the other is to use a specially designed barrel with a hollow trunnion through which the dust is exhausted. Both these methods are shown in the exhibit.

It is also necessary to fence the revolving barrel so that the operator's clothing may not be caught on any projections.

## Buffing Machine with Dust Exhaust and Filter.

This type of machine has two fans driven by one belt from the polishing spindle, and connected by ducts to a dust separator.

The adjustable hoods are connected to the suction side of the fan casings, and so provide a suitable means for the extraction of the dust produced while polishing.

The machine can, therefore, be placed in any position most suitable to the work, and it does not involve the installation of long ducts, etc.

*Lent by*—W. CANNING & Co., Ltd., 133-137, Gt. Hampden Street, Birmingham.

A guard is shown for end of spindle when the mop or bob is not in position.

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### PHOTOGRAPHS.

Safety and dust prevention arrangements in connection with the cleaning and grinding of stove grate, and other castings are shown on Screen XXXVI.

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# BOOT AND SHOE MACHINERY.

## Heel Compressing Machine.

This machine is used for pressing heels. The heels, which are built up of several layers, are subjected to extreme pressure, so that they are turned out like solid blocks of leather. About 1,400 heels may be compressed per hour.

Risk of injury to the worker is minimised by the use of the movable carriage in which heels are placed by hand outside the danger zone, and

by which they are carried mechanically under the press. The heels, when pressed, are also ejected mechanically and fall into the shoot at the back. A safety stop is fitted to the foot pedal.

*Lent by*—THE BRITISH UNITED SHOE MACHINERY Co., Ltd., Union Works, Belgrave Road, Leicester.

## 5-ft. Revolution Press.

This machine is used for cutting shapes out of various materials such as leather, cloth, cardboard, and is used in a number of industries. The hide, sheet, etc., to be cut is placed on the board or block under the top beam, a knife of the shape required is placed upon it and held in position by the operator, and the shape is then cut out by the descent of the top beam on the knife. In the Boot and Shoe Trade up to 1,000 soles may be cut per hour. Typical knives are shown. The beading round the upper edge is designed to prevent the fingers slipping over it and being crushed by the descending beam.

A safety device is provided which makes it impossible, so long as the treadle is kept down, for the machine to operate after making a stroke. The treadle must be allowed to rise to its full height and be again depressed before another cut can be made.

In addition, to guard against the danger of a " repeat " in the event of the brake leather becoming worn or saturated with oil, an automatic Stop Bar comes into action, which makes it impossible to depress the treadle, and so calls the operator's attention to the fact that the brake requires inspection.

*Lent by*—THE BRITISH UNITED SHOE MACHINERY Co., Ltd., Belgrave Road, Leicester.

## 7½-inch Summit Splitting Machine.

This machine is used for splitting or " evening " middle soles, insoles, and heel top pieces. Up to 1,200 pieces may be handled per hour.

The danger of the fingers being nipped between the rollers is avoided by the guard plate in front, which has a slot wide enough to admit the work, but narrow enough to exclude the fingers.

In case of extra thick work, the top part of this slot will lift a little, but it comes down again the moment the work has passed.

*Lent by*—THE BRITISH UNITED SHOE MACHINERY Co., Ltd., Belgrave Road, Leicester.

## SPEED VARIATION GEAR.

P.I.V. speed gear, enabling very small and also larger variations of speed to be made gradually while machinery is under load, the gear itself being enclosed and having an external operating wheel.

*Lent by*—P. I. V. GEAR SYNDICATE, 7, Princes St., Westminster, S.W.1.

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## LADDERS.

The chief dangers to be guarded against with ladders are the breakage of rungs, and the slipping of the ladder, at top or bottom. These may be guarded against partially (1) by inserting under a rung a wire or iron stay ; (2) by fitting the ladder with some form of non-slip attachment at the feet, and (at the top for use with shafting or the like) with hooks, which will grip the shafting, etc.

These precautions are shown in the exhibits :—

(i) A well-built ladder with metal bonds stretched under each rung ; and metal hooks for attachment to shafting.

*Lent by*—A. BEER & SON, North Street, Bedminster, Bristol.

(ii) Extension ladder with rubber non-slip attachments on both feet.

*Lent by*—H. C. SLINGSBY, Kingsway, W.C.2.

(iii) Short length of ladder with rubber non-slip attachments on both feet.

*Lent by*—H. MARSHALL, 205, Burlington Street, Liverpool.

(iv) Non-slip ladder feet for attachment to any ladder.

*Lent by*—HUNTLEY & PALMER, Ltd., Reading.

(v) Non-slip ladder. Non-slip attachments to ladder feet (rubber and steel).

*Lent by*—W. THOMSON & Co., Bolton.

(vi) Non-slip ladder. Non-slip attachments to ladder feet.

*Lent by*—J. H. HEATHMAN, Ltd., Parsons Green, Fulham, London, S.W.6.

(vii) Safety ladder. Light extension ladder reinforced with flexible steel wire and with levelling attachments to feet.

*Lent by*—J. H. HEATHMAN, Ltd., Parsons Green, Fulham, London, S.W.6.

(viii) Non-slip safety mat for use with ladders.

*Lent by*—DORMAN LONG & Co., Ltd., Middlesbrough.

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## *STAIRS.*

### Floor Surfaces.

Some specimens of *Composition Flooring* suitable for factories, giving a smooth hard surface free from splinters, etc., are shown at the top of the stairs leading to the Basement. This can be laid over existing floors.

*Lent by*—F. SIDEBOTHAM, Ltd., Macdonalds Lane, Manchester.

### Non-Slip Stair-Treads.

Several kinds are shown. One consists of alternate strips of carborundum composition and lead, held together in a cast-iron tray, which is either let into the stair-tread or screwed direct on to it. Another consists of a tread with a corrugated surface which can be similarly fixed to the stairs. Others are of rubber.

*Lent by*—
SAFETY TREAD SYNDICATE Ltd., London.
DIAMOND TREAD Co., Ltd., London.
NORTH BRITISH RUBBER CO., Ltd., London.
SORBO LTD., Woking.

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## *BY THE ENTRANCE DOOR.*

### PHOTOGRAPHS.

Safety arrangements in the following Government factories :—

H.M. Dockyard, Portsmouth.
Royal Naval Cordite Factory.
Royal Aircraft Establishment, Farnborough.
Ordnance Survey Office, Southampton.

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# BUILDING OPERATIONS.

During the three years 1930–32, no less than 375 deaths were reported to the Home Office as having been caused by building accidents. The commonest causes of serious accidents are

(1) Falls of workmen from scaffolding, stages, runways, ladders; through openings, etc.
(2) Falls of materials from scaffolding, etc.

At present only part of the industry (namely, constructional work with the aid of mechanical power) has been brought under regulation by the Factory Acts.

The exhibits in this Section include :—

(*a*) A short section of a bricklayer's scaffold (pole).
(*b*) A short section of an independent scaffold (tubular).
(*c*) A section of a suspended scaffold.
(*d*) An improved "boatswain's chair."
(*e*) Hand-operated jib crane with automatic safe load indicator.

## Bricklayer's Scaffold and Independent Scaffold.

The bricklayer's scaffold is the form of scaffolding commonly used in England in the erection of brick buildings. In this form, the inner support for the scaffolding is the wall of the building which is being erected, the outer support being furnished by poles or tubes.

In the other form of scaffolding shown, which is used in the erection of stone buildings, the structure is independent of the building, but for stability is tied to it.

In both forms, either poles or tubes may be used. In the tubular scaffolding, the parts are clamped together by metal couplers or connections. When poles are used the parts are tied together with hemp or wire ropes or chains. The exhibits show several methods of tying.

Scaffolding should possess an ample margin of strength. Materials should be carefully selected; the supports should be carefully set (standards vertical, ledgers horizontal) and should not be too far apart; and the whole structure should be adequately braced and tied so as to resist stresses in any direction.

In the exhibits, the standards or uprights are spaced at a distance of 6 ft., and the putlogs about 3 ft. In the pole scaffold the putlogs are tied to the ledgers and wedged into the wall.

The exhibit illustrates also the following points of safety :—

(1) A firm platform.
(2) Guard rails on the platforms to prevent falls of workmen.
(3) Toeboards on the platforms to prevent falls of material.
(4) Reasonable width of platform for ordinary work (five planks, giving a total width of about 3 ft. 9 in.).
(5) Short overlap of the planks over their supports (putlogs). The overlap is less than 6 in.
(6) Safe means of access—
  (*a*) A ladder, securely lashed to the scaffold, extending more than 5 ft., above the landing and provided with a lath at the top to warn the worker when his hand reaches the end of the ladder. A stop-block at foot of ladder to prevent slipping is also shown.
  (*b*) A fenced gangway from one scaffold to the other.

## A Suspended Scaffold (Section).

In some situations, where a fixed scaffold would be very costly or inconvenient, a working platform suspended from above may be preferred. There are several forms of such scaffolds, including boatswain's chairs, cradles (or swinging scaffolds) and heavier suspended scaffolds.

This exhibit shows a section of a suspended scaffold, especially suitable for use on large buildings. The scaffold can be made of any length, allowing a large number of men to work simultaneously. It is very safe and its weight makes it very stable. The appliance is suspended by means of wire cables from strong outriggers (furnished with stop bolts). The winding drums enable the scaffold to be raised or lowered from the working platform. In order to prevent the fall of workers or materials, the platform is fenced on its outer side and at one end ; ordinarily there would be similar fencing at the other end also, but this is omitted in the exhibit to provide access to the platform.

*Exhibits lent by*—SCAFFOLDING (GREAT BRITAIN), Ltd.

## Improved " Boatswain's Chair."

Occasionally a workman is suspended on a single plank supported by ropes which are " picked up " on the job, and no provision is made for retaining tools or materials. This exhibit shows a " safety " chair with wire ropes permanently attached and with receptacles for tools and materials.

*Lent by*—PEEK, FREAN & Co., Ltd.

## PHOTOGRAPHS.

Safety features in connection with scaffolding, platforms, gangways, etc., are shown on Screen XXVII and in album on table.

## Crane Signal Device.

The use of cranes in docks, and elsewhere, often calls for a look-out man or signalman to instruct the crane driver when the load is ready for hoisting, lowering, etc., and accidents have occurred because signals were misunderstood, wrongly given, or obscured by fog or steam.

The signalling apparatus here shown has been designed to reduce such accidents, and consists of an indicator board, fixed in the crane cab where it is easily seen by the driver, and a key box which is supported by the leather covered hooks from the shoulders of the signalman. The key box and the indicator are interconnected by a long multi-wire cable with the necessary batteries to operate the apparatus. The signalman can be stationed at the loading or unloading point, but need not be visible to the driver. In some cases a telephone is used in place of the key box, and then a loud speaker replaces the indicator in the crane cab.

*Lent by*—THE DICTOGRAPH TELEPHONES, Ltd., Aurelia Road, Thornton Heath.

## Jib Cranes.

Jib cranes of both fixed and travelling types are widely used and numerous accidents have occurred in connection with their use.

The principal causes of crane accidents are :—

Faulty erection (involving unstable conditions).
Overloading.
Misuse.

Overloading is most likely to occur when the crane is fitted with a movable jib, as the load which can be lifted with safety diminishes as the radius of the jib is increased.

*The provision of safe load indicators has recently been made compulsory by the Building (Amendment) Regulations*, 1931, for all jib cranes of over 30 cwts. capacity used in connection with building operations to which Section 105(1) of the Factory and Workshop Act, 1901, applies ; and they are also being adopted voluntarily in many other industries.

The exhibit consists of a small hand-operated derricking jib crane of fixed pillar type. This is fitted with a Vickers-Nash safe load indicator. When the radius of the jib or the load carried is increased beyond the

limit for which the crane is designed, the overload is shown on an indicator visible to the driver and an audible signal is given which continues until the load is reduced within safe limits.

*Lent by*—VICKERS-ARMSTRONG, Ltd., Dartford.

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## PHOTOGRAPHS AND DRAWINGS.

Other approved safe load indicators are shown on the revolving wall screen.

*Supplied by*—

Joseph Booth & Bros., Ltd., Rodley, Leeds.
Henry J. Coles, Ltd., Derby.
John M. Henderson & Co., Ltd., Aberdeen.
Sir William Arrol & Co., Ltd., Parkhead, Glasgow.
Brown & Aitken, Bush House, Aldwych, W.C.2.
Thomas Smith & Sons (Rodley) Ltd., Rodley, Leeds.
H. N. Wylie, 5/6, Clements Inn, Strand, W.C.2.

*Reference :—*

Home Office Building Regulations, 1926, and Amended Regulations, 1931.
Home Office Safety Pamphlet No. 15.—" Derrick Cranes ".

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# SHIPBUILDING ACCIDENTS.

## (Screen XXVIII.)

Shipbuilding is one of the most important of our heavy industries, normally employing over 175,000 persons ; and is also one of the most hazardous, particularly in the earlier stages of ship construction. During 1930–32, 18,816 non-fatal and 128 fatal accidents were reported. The proportion of fatalities and serious injuries is high compared with that in

most industries. The majority of the serious cases are due to the workers falling from gangways or staging on the outside or inside of the ship or through openings in decks or from ladders, and a certain number to falls of loose material or of tools from decks or staging on persons working below.

The exhibit consists of a series of photographs illustrating methods of securing safety, among which may be mentioned :

(1) Good *gangways* of various types with secure fencing at each side. The modern permanent steel gangway is a great advance on the rudely constructed wooden gangway formerly common in the industry.

(2) Use of *steel uprights and steel thwarts* for support of the staging. These are replacing the older type of wooden uprights and thwarts in certain yards. The advantages are that (i) the steel uprights remain rigid, whereas wooden uprights are liable to sway in a wind and displace the staging planks, and (ii) the loose wedges and spikes which are used to secure wooden thwarts and which are liable to work free and fall on persons working or passing below are not needed.

(3) Strongly made *ladders*, properly secured to prevent slipping—an important factor in safe working. Note the *double* ladder which gives greater rigidity than an ordinary ladder, and allows of persons passing—one descending, the other ascending.

(4) Good *Riveters' Stages*, with a guard plank at the back. The practice of using the guard plank is growing, and is most effective in preventing a fall if a worker loses his balance.

(5) Protection for openings in decks, either by permanent fencing round the opening or by the use of temporary covers.

*Reference :—*

Report of Home Office Committee on Accidents in Shipbuilding and Ship Repairing (1924), published by H.M. Stationery Office.

Home Office Shipbuilding Regulations, 1931.

# USE OF ELECTRICITY IN FACTORIES.

The use of electrical energy on factory premises for lighting, heating, motive power and directly for factory processes (e.g., steel furnaces) has enormously increased in recent years and is constantly increasing.

Though electrical energy, properly installed, is probably the safest form of power available, defects in design of apparatus and ignorance or carelessness on the part of those responsible for installing or maintaining apparatus are the cause of a number of accidents every year. Many of them occur with the *low* voltage most commonly used, that is, not exceeding 250 volts to earth, and are for the most part *preventable.*

In the five years, 1929–33, the accidents on *low* voltage systems numbered 792—489 of which were on direct current and 303 on alternating current—but of the direct current accidents only two were fatal, while of the alternating current accidents 63 were fatal.

These figures show that the danger to life is far greater with alternating systems, a fact which is of special importance at the present time, when many direct current public supplies of electricity are being changed over to alternating. Apparatus and methods of installation which may have been good enough for use with direct current are frequently found to be inadequate and dangerous when used with alternating current.

The chief sources of danger found when the Electrical Branch of the Factory Inspectorate was established 32 years ago were the flimsy construction of apparatus; the incomplete protection of conductors, particularly of apparatus which has to be handled, such as fuse boards; the non-earthing of metal work, such as conduit, motor frames, switch covers, lamp-holders; and the faulty construction of portable hand lamps. Owing to ignorance, carelessness, or a desire for cheapness, these faults continue to be repeated and to be the cause of accidents.

Regulations to safeguard the use of electricity in factories were made by the Home Office after an exhaustive public inquiry in 1908. At that time there was very little apparatus on the market so constructed as to comply with the requirements. To-day, as a result of the enforcement of these Regulations, the general standard of design, installation and maintenance of electrical plant, is very much higher, as is shown by the fact that while the use of electrical power has enormously increased the number of accidents has not increased. Nevertheless, though the Regulations have been in force for 25 years, the Inspectors still find a considerable amount of electrical apparatus manufactured and placed on the market which is not in conformity with the Regulations and is dangerous, and which may and does find its way into factories in this

country. The object of this section of the Museum is to show occupiers of factories what is needed to comply with the Regulations and ensure safety, and what they should avoid.

The exhibits illustrate types of electrical apparatus, for use at ordinary voltages, most commonly met with in factory installations and show how requirements of the Home Office Regulations have been met by different makers of apparatus.

The exhibits also include samples of apparatus which do not comply with the Regulations and which have caused fatal accidents. A comparison of these with other exhibits is instructive.

The exhibits necessarily illustrate only a very small part of the field covered by the Regulations and are not intended as a complete exhibition of factory electrical apparatus.

## ELECTRICAL APPARATUS.

### Oil Immersed Switch Gear (excluding flameproof switch gear).

The increase in generating plant capacity and distribution networks of public and private supply systems has brought into greater prominence the necessity of using switch gear having a rupturing capacity adequate to withstand the forces set up by the greater release of energy under fault conditions. Several explosions resulting in destruction of apparatus and/or injuries to persons employed have resulted from oil circuit breakers of inadequate rating failing to operate satisfactorily. The photographs show some effects of switch gear failure.

Switch gear must accordingly be so constructed as to prevent this danger and it is advisable that the apparatus should pass the tests specified in British Standards Institution Specification No. 116.

Space does not permit of the exhibition of switch gear of large rupturing capacity, but typical examples are indicated in photographs.

A section model is shown of a 6,600 v. 3-phase ironclad oil switch unit.

Another exhibit is a 2,000 v. single phase oil switch with vertical isolation—suitable for use where floor space is limited.

### Control Gear.

This group comprises gear for controlling the supply of current to motors, designed to prevent excessive overload when starting or running the motor. The gear will automatically break circuit when the

current exceeds a predetermined figure ; it will also do this when the voltage falls below a certain point, so as to prevent damage in the event of the voltage being suddenly restored. Time delay action may also be incorporated to prevent the circuit being broken by a purely momentary overload.

Detailed notices are attached to the exhibits, but attention is drawn to the following general points :—

Totally enclosed construction.

Means of isolation, in some cases interlocked with the door or operating handle, to provide a ready and safe method of making contacts and other parts dead for attention or overhaul.

Provision for operation by means of push buttons. This method has two advantages—

(*a*) It prevents possible damage to apparatus by hurried or incorrect starting.

(*b*) Push buttons can be placed in convenient situations in the works to enable driven machinery to be stopped instantly in case of danger or emergency.

A section of the transmission machinery on the ground floor is controlled in this manner.

## Weather Proof and Dust Proof Apparatus.

Conductors and apparatus intended for use out of doors or with wet processes or in dusty situations must be specially protected (*see* Electricity Regulation No. 27).

Lighting fittings are shown which consist of a housing with outer glass globe ; percolation of water or dust through joints is prevented by the insertion of rubber or similar packing rings under compression. Glassware in situations where it is likely to be subject to mechanical damage should be protected by a metal guard or cage.

The connections to the fittings must also be protected either by enclosure in screwed conduits or metal sheathing. The method of attachment should allow for air expansion and contraction (" breathing ") due to heating and cooling of the fitting.

An exhibit of a fitting under water which can be lighted from the switch below the tank is shown. In this example " breathing " takes place through the metal sheathed cable.

In dusty situations it is important that the temperature rise of the fitting should not approach the ignition temperature of any dust that may collect on the housing.

Motors may be of the totally enclosed or pipe ventilated type. In the latter case, the pipe inlet should be placed outside the dust zone.

Standards Specifications for this type of apparatus are published by the British Standards Institution.

## Flameproof Apparatus.

Regulation No. 27 of the Electricity Regulations requires that " All conductors and apparatus exposed to inflammable surroundings or explosive atmosphere . . . shall be so constructed or protected and any special precautions shall be taken as may be necessary adequately to prevent danger in view of such exposure."

To prevent open sparking in a dangerous atmosphere, special enclosure is necessary. In practice, it is impossible to maintain enclosures always gastight and the principle of " flameproof " enclosure is considered to be the only safe method. Such an enclosure is not constructed to exclude gases, but to withstand internal explosion and cool the emitted hot gases by passage through suitable devices so that they reach the external atmosphere at safe temperatures. The method of cooling usually adopted is passage between wide metal flanges.

Exhibits shown in this group are designed on this principle, and also comply with British Standards Institution Specifications.

The Mines Department carry out tests and issue certificates as to apparatus deemed to be " flameproof."

It should not be overlooked that apparatus certified merely for use in mines in methane-air mixtures (firedamp) is not necessarily suitable for use in other industrial processes. Certificates can, however, be obtained from the Mines Department as to suitability for pentane-air (petrol vapour) and for hydrogen-air (acetylene) mixtures.

## Corrosion Proof Apparatus.

Serious trouble may be experienced in chemical, dye and other works where acids or other corrosives are present, if ordinary metal fittings, conduit, etc., are used. The systems of wiring shown in this group are designed to resist corrosion. One system is made entirely of ebonite, both as regards conduit and fittings ; another is similar, but the conductors are rubber sheathed, the fittings being designed to protect the connections between wiring and apparatus.

Other exhibits show fittings made of composition and so arranged as to protect from the action of a corrosive, by means of an oil seal, the joint between the wiring and the apparatus connected.

Insulating shoes suitable for use in battery rooms, and insulating gloves for special work, e.g., in test rooms, are also shown.

## Combined Switch and Fuse Boxes.

Switches and fuses for controlling branch circuits or motors are conveniently made up in one piece of apparatus. To protect the operator against touching live metal when the outer covers have to be opened, the covers are interlocked with the switch-handles so that they can only be opened when the switch is " off." If, as is the proper practice, the switch is connected to the incoming supply, the fuses will be " dead " when the cover is opened. The " live " parts of the switch will require to be specially protected, and the apparatus in this section shows the arrangements adopted by different manufacturers. It is, for instance, shown that the live switch contacts can be deeply recessed in an insulating shrouding. Some of the switches have a " quick-make " as well as " quick-break " action —a device which obviates the risk of a " partial contact."

## Fuses and Fuse Boards.

All circuits require to be protected from an excess of current. This is done by means of automatic circuit-breakers or by fuses. Fuses are generally used except for the heavier circuits, and are conveniently grouped together on distribution fuse boards. The proper construction of these is important. All live metal must be protected so that it cannot be touched. General protection is provided by enclosing the fuses in a cabinet, but it is also necessary to secure that live metal, e.g., the bus-bars, fixed contacts, cable lugs, etc., cannot be inadvertently touched when the cabinet is opened, e.g., to renew a blown fuse. The fuse holders must also be so constructed that a fuse wire may be removed and replaced without risk of touching live metal and that the hand is shielded from the arc should a fuse blow on being inserted.

The exhibits show how these requirements have been dealt with by different makers.

A feature of one exhibit is a neon tube incorporated in the fuseholder. The tube lights when the fuse blows and thus indicates at once the interrupted circuit.

For purposes of comparison a number of dangerous types of fuses are exhibited.

In selecting types and sizes of fuses it is important that rupturing capacity should be taken into consideration. A fuse connected near a power station or other large source of supply will have to deal with a greater flow of energy in the event of a short circuit than one connected some distance away ; and if it had insufficient rupturing capacity " arcing " involving risk of fire or explosion may result. Selection should, therefore, be based not so much (as is commonly done) on whether the fuse is designed to carry the current normally used as on whether it can be relied upon to interrupt the circuit with safety under short circuit conditions.

Examples are shown of fuses designed to specified rated rupturing capacities and, for certain sizes, to meet the requirements of British Standards Institution Specifications.

## Connector Plugs and Sockets.

It is essential that a safe form of connector should be used for connecting portable apparatus to the electricity supply.

In the old type of connector plug the flexible wires passed through the centre, and so through the user's hand, and the insulation was very liable to get worn at the point where the wires pass out of the plug, and a short circuit to result. Where this happened, the user's hand might be severely burned. Further, the user was liable, when putting the plug in or when drawing it out of the socket, to make contact with the pins of the plug when they were live, and fatal accidents have occurred from this cause. An example of this dangerous type of plug is shown.

To overcome these defects a form of plug was suggested by the Electrical Inspector of Factories in his Reports for 1908 and 1909, having :—

(*a*) The entry of the flexible wires at the side of the plug and not at the end, so reducing the wear on the insulation at this point ;

(*b*) a disc of insulating material between the hand and the wires ; and

(*c*) a hand-shield with a handle on the side away from the contacts.

In the event of a short circuit the operator's hand is shielded from the flash, and the hand shield also prevents him from inadvertently taking hold of the live pins of the plug.

Connector plugs should be constructed so as to grip securely heavily protected cable. Examples of different methods are shown.

In the case of most portable apparatus, other than safety type headlamps of the type shown in the Lighting Fittings group, a suitable connection must be provided for earthing the metal of the portable apparatus.

This usually takes the form of an extra contact pin, and most of the exhibits shown possess this feature. It is important to ensure that the earth pin cannot be made to touch either of the live contacts of the socket, or the portable apparatus may be made live and bring about just such an accident as the earth wire is intended to prevent. Methods of achieving this are shown in the exhibits—for example, by making the earth pin larger than the others.

It is also important that the conductor wires and the earth wire should be in separate channels within the plug, so that the earth wire cannot accidentally come into contact with either of the conductors.

Connector plugs may be safely used for small circuits, such as portable lamps, without the use of a switch. For the heavier circuits, however, a switch is necessary in addition. Single pole switches will not suffice unless one pole of the circuit is connected to earth, and unless the switch is connected in the non-earthed pole.

Connector plugs and sockets may be conveniently mounted with a switch on the same fitting and several examples are shown. In some cases the switch is double pole.

Additional safety is secured by the plugs being interlocked with the switches so that they cannot be put in or taken out when the switch is on.

In order to prevent mistakes in wiring up plugs and sockets they may now be obtained with polarity markings in standardised sequence.

## Miscellaneous.

It is frequently found that earth wires are " connected " to conduit or water pipes merely by twisting a few turns round the conduit or pipe. This method is inefficient and often quite useless. Earthing grips or clamps, to make a sound mechanical and electrical connection to the conduit or pipe, should be used, the earth wire being secured by a suitable terminal on the clamp, or by soldering. The exhibits illustrate some forms of these.

The ceiling rose (shown) is designed to facilitate the ready attachment or renewal of the flexible. The flexible is attached to terminals in the cover, which is readily detachable, so that the connection can be made at the bench instead of from a ladder at the ceiling.

An electrically heated panel radiator is exhibited. No live parts are accessible.

## Screw-Cap Type Lampholders.

The great increase in recent years of high candle-power reflector lighting has resulted in a much wider use of electric lamps of which the caps are of the screw pattern instead of the " bayonet " type. With this type of lamp the screw is designed to form part of the electric circuit, and the metal cap of the lamp is liable to be dangerous if touched. The object of this exhibit is to show how such danger arises and methods of preventing it.

No less than six fatal accidents in connection with screw-cap lamps were notified under the Factory Acts during 1930, and other accidents are reported to have occurred on premises not under those Acts. Some of the actual lampholders involved in these fatalities are shown in the exhibit.

There is no danger from the cap if the lampholder is properly connected up, but experience unfortunately shows that the connections are often wrongly arranged. The exhibit shows five different methods of wiring, only one of which can be regarded as satisfactory. It will be appreciated from this that the chances of mistake in connecting up such lampholders are by no means remote, and this is perhaps particularly the case where, as in one of the methods shown, the lampholder is connected to the supply through an ordinary two-pin wall plug ; in such a case one has only to put in the plug the wrong way round and the cap of the lamp becomes " live." A testing device is installed which enables the visitor to test for himself with safety whether the cap of the lamp is " live " on each of the five exhibits of wiring methods and with the switches in different positions—it will be seen that in some cases the cap is " live " even when the light is turned off.

As a safeguard against results of incorrect wiring the exhibit shows a number of lampholders with an extension or " skirt " coming well beyond the cap of the lamp to prevent it being accidentally touched. The leading manufacturers are now in a position to supply lampholders of the skirted pattern ; and separate skirts have also been designed for fitting to existing unskirted lampholders, though this may not always be possible. Examples of such separate skirts are also shown in the exhibit.

Portable lamps with screw-cap lampholders are often used in connection with the erection of buildings. Mention has already been made of the danger of using such lamps connected to the supply through ordinary two-pin reversible plugs, unless the lamp cap is completely protected against accidental contact by a " skirt " or similar device. It is very desirable that portable lamps used in connection with building and other operations where they may receive rough usage should be of the safety pattern, with strong outer guards of close mesh, and that, where screw-cap lampholders are used at all, the skirts should be as robust as possible.

# LIGHTING FITTINGS.

## Safety-Type Electric Hand-Lamps.

Many fatal shocks have been caused through the use of dangerous types of electric hand-lamps (connected to ordinary electric lighting circuits by flexible wires) in which the metal lamp-holder has been attached to other metal work, e.g., to a " gallery " supporting the wire lamp guard or in some cases to a metal tube passing through the wooden handle and terminating in a knob or hook. Through some minor defect in the lamp-holder, or through the insulation of the flexible wires being worn away, the whole of the metal work becomes electrically charged. If the person holding the lamp happens, for example, to be standing on damp ground or a damp brick or concrete floor or on metal plates or to touch a metal girder, he receives a shock and may be unable to drop the lamp. A makeshift hand-lamp, consisting merely of a lamp in a metal lamp-holder is often used by electrical workers and is equally dangerous, Specimens of portable lamps which have actually caused fatal accidents are exhibited in Case P.

The Home Office Regulations require that the lamp-holder shall not be in metallic connection with any other metal work and that all metal work other than the holder shall be earthed. As an alternative to earthing, which is troublesome with hand-lamps, it was suggested by the Electrical Branch of the Home Office in 1910 that the lamp should be so constructed that there are no exposed metal parts which can possibly become live. The handle and body of the lamp should be of hardwood or other insulating material, and the lamp-holder, together with the metal cap of the lamp, should be entirely shrouded by insulating material. Many firms now make " safety " hand-lamps of this type and several are shown in this Group. For factory use, heavily protected flexible is required and a suitable grip or gland should be provided in the handle to grip the protecting cover and so take the strain off the conductors.

Hand-lamps are exhibited with the lamp guard also of insulating material, making the hand-lamp safe for use near live conductors (as at open-type switchboards or for examining cells in battery rooms) where a lamp with a wire guard if carelessly handled might lead to a short-circuit.

Attention is directed to the following special features :—

Heat-resisting hand-lamps suitable for use where high temperatures may be expected, as in brick kilns.

Safety type barrel or tube inspection lamps.

Portable transformer to provide a low voltage (25 volts) supply to hand-lamps for use in specially dangerous situations such as the insides of boilers or tanks or in very wet processes.

## "Cargo" Lighting Clusters.

Lighting clusters used for night work in docks, etc., are attended with the same risks as portable lamps, but owing to their size and the rough usage to which they are exposed, it is not practicable to guard against the risks by making the fitting entirely of insulating material as in the case of hand-lamps. The lamp-holders should be insulated from all other metal work, including the shade reflector, and shrouded with insulating material so that they cannot be touched. Also, the shade and all other metal parts must be earthed by means of a third wire in the flexible cable.

Examples of two safe makes are shown, and a specimen of the common dangerous type, which does not comply with the Home Office Regulations. This specimen has actually been the cause of a fatal accident, the reflector and other metal work becoming live through a small defect in one of the eight lamp-holders.

## Lamp-Holders (Insulated Pattern).

In many positions in factories, e.g., where the floors are damp or of iron or otherwise "conducting," metal lamp-holders require earthing in order to render them safe in case of leakage. Fatal accidents have occurred when this has not been done. When they are screwed on to earthed conduit there is no difficulty, but where flexible pendants are used a third wire is necessary to effect the earthing. In order to obviate the use of a third wire, the lamp-holders can be rendered safe by enclosing them in suitable insulating material. The design should be such that the insulating covering covers the cap of the lamp as well as the holder and that a metal shade can be attached without coming into contact with any metal part of the holder. The exhibits are designed in this manner. The extension "skirt" should be noted.

An insulating holder is even more important in the case of lamp-holders combined with switches, as these holders are handled every time the lamp is switched on or off. In examples shown, the switch is actuated by a push-bar, which is insulated from the live parts.

## Air-Break Switches.

This group comprises various patterns of switches used in factories for the smaller motors or for lighting circuits.

Examples are shown of switches which are of the quick-make and quick-break type and the covers of which are interlocked with the switch-handles, so that the cover cannot be opened unless the switch is first placed in the "off" position.

In many positions in factories, e.g., where the floors are damp or of iron or otherwise "conducting," switch covers have to be earthed. Ironclad switches are readily earthed through the screwed conduit, or by means of an earth wire attached to a terminal on the case. Small switches of the tumbler type having metal covers and dollies are not readily earthed unless specially designed to facilitate earthing. Examples are shown, provided with earthing terminals so that the covers and dollies can be earthed. Others are earthed through the metal boxes in which they are enclosed.

The necessity for earthing the switch covers in certain cases can be avoided by making the covers and dollies of a tough insulating composition. Switches of the tumbler type, and also rotary switches having a specially high rupture capacity, are shown constructed in this way.

Special features in this group are :—

Tumbler switch with neon tube in cover. Tube glows when switch is off and indicates position in a dark room.

Tumbler switch with internal red disc over live contacts and marked "danger." Suitable for use where switch covers are likely to be removed by unauthorized persons.

## Portable Apparatus.

All portable apparatus must be connected to the circuit by safe types of connectors (*see* Plugs and Sockets Group) and (except safety handlamps or the type shown in Lighting Fittings Group) must be earthed.

A length of trailing cable is exhibited suitable for connecting a travelling electric crane. The conductors are heavily insulated and protected mechanically by an inner wire braiding and an outer tough rubber sheathing. An additional conductor is included to form an earthing connection to the crane. An automatic cable reel for taking up slack flexible, which is useful in workshops and garages in order to keep the cable off the floor, where it is liable to damage, is also shown.

The other exhibits include electric drill, grinder, soldering iron, gluepot, and tailoring iron.

A counterweight is shown for the grinder and drill, so that the operator does not have to support its weight, and a feature of the electric tailoring iron is the arrangement to offset the flexible cable so as to prevent abrasion of the user's arm.

## Substations.

For reasons of economy, steel substations are becoming more popular with Electricity Supply Undertakings ; but they were not at first well designed from the point of view of safety. The model steel substation (about one-third full size) here exhibited shows a good design for one type of this class of premises.

The model shows a step-down transformer with complete equipment of switchgear for operating from an extra high pressure ring main and supplying low pressure circuits.

Variations are possible in circuit arrangements, but the features illustrated by the model are applicable to the type, and show methods of complying with the Electricity Regulations.

(1) Enclosure of all extra high voltage parts.

(2) Provision of separate compartments for each set of isolating switches, for oil switch, and for each ring main cable end, with facilities for making test connections to the cable end when a ring section is isolated.

(3) Transformer screened from the lower pressure switchgear by dividing partition.

(4) Insulating stand in front of the lower pressure switchgear.

(5) Exclusion of lights and switches from dangerous places near live conductors. In the model a portable handlamp is provided.

Various types of fuse boards, switches, connector plugs, motor starters or controllers, and other electrical apparatus illustrating safety features, are shown as part of the light and power installation of the Museum building.

*Exhibits contributed by—*

ARTIC FUSE & ELECTRICAL MANUFACTURING Co., Birtley, Co. Durham.
BENJAMIN ELECTRIC Co., Ltd., Brantwood Works, Tariff Road, Tottenham, N.17.
BERRY'S ELECTRIC, Ltd., 85/86, Newman Street, Oxford Street, W.1.
E. N. BRAY, Walthamstow.
BROOKHURST SWITCHGEAR, Ltd., Chester.
CONSTRUCTORS, Ltd., Imperial House, Charlotte Street, Birmingham.
J. A. CRABTREE & Co., Ltd., Lincoln Works, Walsall.
DONOVAN & Co., 47, Cornwall Street, Birmingham.
ELECTRICAL APPARATUS Co., Ltd., Vauxhall Works, South Lambeth Road, S.W.8.
GENERAL ELECTRIC Co., Magnet House, Kingsway, W.C.2.
W. T. GLOVER & Co., Ltd., Trafford Park, Manchester.
HOLOPHANE, Ltd., Elverton Street, Vincent Square, S.W.1.

INDIA RUBBER GUTTA-PERCHA Co., Ltd., Silvertown, E.16.
LONDON ELECTRIC FIRM, Brighton Road, Purley.
W. LUCEY & Co., Ltd., 1, Eagle Ironworks, Oxford.
MATHER & PLATT, Ltd., Park Works, Newton Heath, Manchester.
MIDLAND ELECTRIC MANUFACTURING Co., Ltd., Barford Street, Birmingham.
PARMINTER, HOPE SUGDEN, Ltd., Longsight, Manchester.
RECORD ELECTRICAL Co., Ltd., Broadheath, Altrincham, Cheshire.
REVO ELECTRIC Co., Ltd., Tipton, Staffs.
A. REYROLLE & Co., Ltd., Hebburn-on-Tyne, Co. Durham.
SANDERS & Co., Falcon Electrical Works, Wednesbury.
SIMPLEX ELECTRIC Co., Ltd., 219, Tottenham Court Road, W.1.
ST. HELEN'S CABLE & RUBBER Co., Ltd., Slough, Bucks.
STELLA CONDUIT Co., Ltd., Highfield Works, Bilston.
SWITCHGEAR & COWANS, Ltd., Elsinore Road, Old Trafford, Manchester.
J. H. TUCKER & Co., Ltd., King's Road, Tyseley, Birmingham.
VERITYS, Ltd., 31, King Street, Covent Garden, W.C.2.
WALSALL HARDWARE MANUFACTURING Co., Ltd., Hatherton Works, Ablewell Street, Walsall.
WATFORD ELECTRIC & MANUFACTURING Co., Ltd., Whippendell Road, Watford, Herts.

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*IN ROOM ADJOINING LECTURE ROOM IN BASEMENT.*

## Electric Welding by Alternating Current.

Electric welding is most safely carried out by means of direct current, and in cases where alternating current only may be available special precautions are necessary. In this exhibit, by means of a specially made regulator, which modifies the wave form of the current, the open circuit pressure is limited to a maximum of 70 volts, as against 110 volts or 120 volts required by the use of an ordinary transformer with resistance. Incidentally, the power-factor is much improved.

The electrode holder is specially constructed with a protective insulating flange to prevent risk of contact with the live portion.

The Welder's Screen is constructed of non-conducting material and the glasses in it are a combination of blue and ruby, affording protection to the eyes of the operator from the rays of the arc.

The exhibit includes the necessary accessories for welding, e.g., gauntlets for shielding the hands from the arc and from hot particles of metal, a chipping hammer, wire brush, chipping screen with clear

glass to protect the eyes from chips of slag, ammeter, switch and steel-top welding bench, the whole being set out in a " welding bay " protected on each side by canvas screens to prevent the rays from the arc reaching other workers in adjacent bays. In a factory the screening would be taken completely round the bay. Complete screening is required, as painful eye injuries may be caused to persons who may look at the arc even from a considerable distance and for only a few moments.

*Lent by*—THE QUASI ARC Co., Ltd., Grosvenor Gardens, S.W.

Another welder's screen, fitted with a special glass which it is claimed affords complete protection against the harmful rays, is also shown.

*Lent by*—THE EQUIPMENT AND ENGINEERING Co., Ltd., Norfolk Street, Strand, W.C.2.

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*IN GALLERY*—continued.

## DOCKS, WHARVES AND QUAYS.

### LOADING AND UNLOADING OF SHIPS. (Screen XXIX.)

The exhibit consists of photographs taken under the direction of the Factory Department, to illustrate dangers connected with work at docks, and precautions taken in pursuance of the Home Office Regulations.

Attention may be drawn in particular to the following :—

(1) Good gangways of different types, affording safe means of access from quay to ship, or from one ship to another, under varying conditions.

(2) Ladders designed and arranged to afford—
  (*a*) Safe access to ships' holds.
  (*b*) Safe access to cranes.
  (*c*) Means of escape from the water.

(3) Fencing of—
  (*a*) Ships' winches (including extended shafting).
  (*b*) Hatchways.
  (*c*) Crane platforms.
  (*d*) Dangerous parts of quays.

(4) Miscellaneous safeguards such as rings and other handholds near hatchways, methods of securing hatch beams, life-saving appliances at suitable places.

(5) Defective arrangements, e.g., ladders bent or with broken rungs, or placed in dangerous positions; steam allowed to exhaust where it may obstruct view of swinging loads and other dangers; unsatisfactory stacking of timber near side of quay.

Accidents reported at Docks :—

| | Non-fatal. | Fatal. | Total. |
|---|---|---|---|
| 1930 .. .. .. | 6,687 | 74 | 7,434 |
| 1931 .. .. .. | 5,251 | 60 | 7,515 |
| 1932 .. .. .. | 4,940 | 68 | 6,943 |

See also Crane Signal Device. Page 85.

*References :—*

Home Office Docks Regulations, 1934.
Home Office Safety Pamphlet No. 15.—"Derrick Cranes".

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## RAIL LINES AND SIDINGS.
### (Screen XXXIII.)

The exhibit consists of photographs taken at different works to illustrate the dangers incidental to the movement of waggons, etc., on factory sidings, and precautions taken under the Home Office Regulations.

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# LIFTING GEAR.

Lifting gear is used in many kinds of industrial processes, and numerous accidents, causing injuries to workers as well as much damage to material and plant, occur in connection with its use.

A large proportion of the accidents are due to defects of material, construction, maintenance or methods of use, and are liable to occur in any industry in which lifting gear is used : and the precautions required are the same in all.

The exhibit includes specimens of the chief types of lifting gear, which may be classified in four groups :—

(*a*) fibre ropes and slings ;
(*b*) wire ropes and slings ;
(*c*) chains and chain slings ;
(*d*) hooks, shackles, eye-bolts and pulley blocks.

Specimens of defective gear which have given rise to accidents are shown ; also safe and unsafe methods of working ; rules for the guidance of workers as to safe working loads (Screen XXX) ; mode of storing gear when not in use.

Attention may be specially drawn to the exhibit in Cases S. and T. of the research work carried out for the Home Office by the National Physical Laboratory as to the causes of failure of, and the value of annealing wrought iron chains.

*References :*

Memorandum on Chains and other Lifting Appliances, by G. S. Taylor, H.M. Inspector of Factories : Home Office Safety Pamphlet (No. 3) On the Use of Chains and other Lifting Gear. Both published by H.M. Stationery Office.

## Fibre Ropes.

Fibre ropes are preferred by many users because they : (1) are easy to handle ; (2) do not cause damage to finished machine parts ; (3) are comparatively inexpensive and can therefore be scrapped as soon as they show signs of wear.

Accidents due to failure of fibre ropes are not uncommon and the risk of these can be minimised by (1) using only ropes made from fibre of suitable quality ; (2) storing ropes in places where they are not subject to damp, high temperatures or corrosives ; (3) frequently examining

ropes for wear, cuts or other damage ; (4) replacing a rope as soon as it shows signs of appreciable wear or damage or the fibre has lost its elasticity and become brittle. Rope slings should be stored on racks (as in the exhibit) to avoid damage.

This section of the exhibit includes :—

In Case Q—

(1) Specimens of suitable and unsuitable fibres for lifting ropes.
(2) Samples of ropes made from suitable and unsuitable fibres.
(3) Specimens of worn and damaged ropes, some of which have given rise to accidents.

On the racks—

(4) Rope sling showing method of marking with identification number, working load and date when taken into use.
(5) Rope slings made with proper splices.
(6) Specimen of worn slings.

## Wire Ropes.

Accidents in connection with wire ropes arise from two main causes, (1) failure of the rope, and (2) penetration of the worker's hand by broken wires, often giving rise to septic wounds. In a period of three years, 209 cases of failures of wire ropes were reported, causing 16 fatal and 139 non-fatal accidents.

The main causes of failure were needling and excessive wear, overloading, corrosion, overwinding, cutting on sharp edges, splices drawing.

*Needling, excessive wear and corrosion* can usually be detected by periodical examinations, and *internal corrosion* can be minimised by proper lubrication of the rope during manufacture and when in use.

An important point is the size of the pulleys over which the rope passes. If the pulley is so small in diameter as to cause excessive bending, the wires are liable to fracture more readily. British standard Specifications for wire ropes for various uses, e.g. Lifts and Hoists, Cranes and Shipping Purposes, are published by the British Standards Institution.

The risk of *overloading* can be minimised by the proper instruction of slingers and the provision of tables and diagrams showing safe working loads for various sizes and types of ropes, or by attaching to ropes rings or labels showing the safe working loads.

*Overwinding* can be largely avoided by the use of overwinding devices.

*Cutting of slings on sharp edges* can be minimised by the use of proper packing, and the use of damaged ropes can be obviated by frequent examination.

*Splices*, if properly made and of adequate length, will rarely draw out or fail.

The Home Office Regulations for docks require (1) the testing of wire ropes, (2) their periodical examination, (3) the discarding of rope showing needling or excessive wear, (4) a minimum length and special form of splice.

The Wire Rope section of the exhibit includes :—

In Case Q—

(1) Samples showing various constructions of wire ropes.
(2) Methods of marking or indicating safe working loads.
(3) Pieces of worn, damaged, or corroded wire ropes, some of which have given rise to accidents.

On the racks—

(5) Samples of wire rope slings.
(6) Examples of good and bad splices.

## Chains.

Failures of chains are mainly due to defective materials and welds, brittleness of the metal caused by use, overloading, excessive wear, deformation and damage due to overloading or contact with sharp edges or misuse.

Chains are generally manufactured from wrought iron, and the selection of a suitable quality of material is of the utmost importance. Links should be designed as small as possible to secure the greatest strength, and short-link or close-link chains are normally used for lifting purposes. The soundness of the material and welding in a chain is tested by subjecting it to a tensile stress under what is known as the Admiralty Proof Load.

*Brittleness* can be prevented by periodical annealing. *See* exhibit in Cases S. and T.

*Overloading.*—Even under favourable conditions of working the safe working load should not exceed one-half the " Proof Load " for the given size of chain, and where the chain is subjected to shocks or abnormal use, lower working loads should be adopted. The sudden application or jerking of a normal load may have the same effect as an excessive load.

The danger of overloading can be minimised by supplying workers with full information as to the correct sizes of chains and methods of slinging —*see* Screen XXX.

*Wear* and *damage* can only be met by frequent examination and the discarding of worn or damaged chains.

The Home Office Regulations for docks and building operations require the testing of chains before use, periodical annealing and examination, prevention of overloading, the recording in a register of the history of each chain.

The importance of recording the history of lifting chains has long been recognised. A card register is a convenient method of keeping these records where large numbers of chains are in use, and is adopted in many factories.

The Chains section of the exhibit includes :—

In Case R—

(1) Samples of sound and defective materials.
(2) Defective welds, some of which have caused accidents.
(3) Samples of badly worn, damaged and overloaded chains.

On the racks—

(4) Samples of welded and weldless chain slings, with various attachments.
(5) Samples of badly worn chain.

## Hooks.

Large crane hooks are usually mild steel forgings. Hooks for slings are usually made from wrought iron, although mild steel hooks made by drop stamping are being increasingly used for slings.

Accidents in connection with hooks arise from four principal causes :— (1) Failure of the hook by fracture or straightening out ; (2) displacement of the sling from the hook ; (3) point of the hook catching under some fixed structure (e.g., ship's coaming) ; (4) nipping of slinger's fingers between sling and hook.

Failures of hooks are generally due to overloading, but they may also arise, as in the case of chains, from fracture of the material due to brittleness set up in service. Overloading can be generally avoided by the marking of safe loads on hooks and the issue of instructions in connection with their use. All hooks should be periodically examined in order to detect any cracks or deformation, and wrought iron hooks should be periodically annealed in order to remove any brittleness. Accidents from causes (2) and (3) above may be prevented by a special design of hook (as shown in the exhibit), and a handle or shackle is sometimes fitted at the back of a hook in order to obviate cause (4).

This section of the exhibit includes :—

In Case R—

(1) Samples of worn and fractured hooks, shackles and parts of blocks, some of which have given rise to accidents.

On the racks—

(2) Samples of hooks attached to chain slings.
(3) Samples of swivelling and safety types of hooks.
(4) Samples of different types of shackles and shackle pins.
(5) Samples of different forms of pulley blocks.

## Pulley Blocks.

Accidents in connection with pulley blocks mainly arise from overloading. This is largely due to the fact that considerable ignorance prevails as to the safe working loads for blocks, and that hitherto it has been the practice of block makers to mark their blocks with test loads instead of with working loads. The Home Office Regulations for docks now require that all gin and pulley blocks used in loading and unloading processes shall have the safe working load clearly stamped upon them, and that all blocks taken into use after 1st June, 1934, shall have passed a prescribed test, and that certificates of the test shall be entered in a register.

Accidents also arise from fractures of the pins due to excessive wear through lack of lubrication and working in grit, etc.

This section of the exhibit includes :—

In Case R—

(1) Samples of worn and fractured hooks, shackles and parts of blocks, some of which have given rise to accidents.

On the racks—

(2) Samples of hooks attached to chain slings.
(3) Samples of swivelling and safety types of hooks.
(4) Samples of different types of shackles and shackle pins.
(5) Samples of different forms of pulley blocks.

## The Causes of Failure of Wrought Iron Chains, and some Preventive Measures.

Wrought iron finds extensive application in the manufacture of chains on account of its ductility and good welding properties. Cases of failure in practice can be attributed to defects in the original material, to deterioration in service, or to obvious misuse. The exhibits are planned to illustrate in a concise manner these features.

If the iron is overheated either in one of the iron-making operations or in the smith's forge, it is said to be " burnt," and in that condition may be dangerously brittle, leading to sudden failure, especially under a suddenly applied load.

Imperfectly closed welds leave the chain in a weak condition, and it has been shown that a progressive deterioration of the welds occurs during service.

No mechanical or heat treatment can restore a chain to a safe condition where it is defective through any of the foregoing causes.

During service the links of a chain are subjected to repeated small impacts through snatches on the sudden application of a load, the chain dropping to the ground, running through pipes or over guide pulleys and cleaning operations in a rumbling machine. These repeated small impacts produce a hardened surface skin of comparatively small depth. This highly brittle skin, which occurs chiefly on the inside of the crown of the links, cracks very readily, especially when a load, which may be well within the prescribed safe load for the chain, is taken up suddenly. The fine nature of the fissure produced in the brittle skin causes the crack to spread into the ductile core as though the latter were also in an embrittled state, and sudden failure results. Periodic annealing (heating to 650° C. for an hour and slowly cooling), or normalising (heating to 1,000° C. for 15 minutes and cooling in air) by causing recrystallisation of the material in the hardened skin, restores the ductility of the link, and provided a crack has not already started, the useful properties of the chain are recovered. If the periodic annealing process is discontinued and the chain remains in service, it becomes embrittled again.

In the case of mild steel it is known that alternate straining and annealing may give rise to weakness through the production of coarse crystallisation, but no such effect is found in wrought iron. Frequent periodic annealing is therefore a practice which should be adopted wherever possible for wrought iron chains.

The exhibits (cases S and T) summarise the results (leading to the above conclusions) of a research—initiated at the request of the Home Office and approved by the Engineering Research Board of the Department of Scientific and Industrial Research—which was carried out in the Engineering and Metallurgy Departments of the National Physical Laboratory. This investigation was undertaken for the purpose of determining the value of annealing or other heat treatment as a means of preventing the failure of lifting chains used in industrial operations. The results of the

experiments are of considerable interest and are shown in this exhibit classified under the headings :—

1. Failures due to defects in manufacture.
2. Failures due to deterioration of welds.
3. Failures due to brittleness produced by service.

The experiments have demonstrated conclusively that annealing removes the brittleness due to service, and, if done regularly, prevents a chain from becoming brittle. Normalising is an alternative heat treatment which is equally effective, but usually less convenient for the chain owner, because of the higher temperatures required.

*Reference :*

Notes on Annealing and Use of Wrought Iron Chains. Published by H.M. Stationery Office.

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## FIRE PREVENTION AND ESCAPE.

The exhibit illustrates various arrangements and appliances for dealing with outbreaks of fire at factories before the arrival of the fire brigade and for assisting the local or works brigade as the case may be.

### Alarm System.

The " Pearson " alarm system, which operates when the heat, acting upon two sensitive metal strips, causes them to expand and come into contact. The contact closes an electric bell and indicator circuit. A compensating device is provided which, it is claimed, prevents the contact taking place when the temperature is increased for a few moments only.

*Lent by*—ASSOCIATED FIRE ALARMS Ltd., London.

## Extinguishers (shown in section where possible).

(1) Soda acid type, for wood, textile and general risks.

*Lent by*—H.M. OFFICE OF WORKS.

(2) Plain water extinguisher, for places where delicate fabrics, textiles, or furniture might be damaged by the slight corroding effect which occurs when machines of type (1) are employed.

*Lent by*—READ & CAMPBELL, Ltd., 75, Victoria Street, S.W.1.

(3) Foam type, for oil and spirit fires.

*Lent by*—THE FOAMITE FIREFOAM, Ltd., 55, Great Marlborough Street, W.

(4) Carbon tetrachloride type, for motor car and electric fires.

*Lent by*—THE PYRENE Co., Ltd., 9, Grosvenor Gardens, S.W.1.

(5) "Total" extinguisher from which finely powdered bi-carbonate of soda is expelled; suitable for oil and tar fires. The jet offers high resistance to electric current.

*Lent by*—TOTAL (Overseas) Ltd., 58, Victoria Street, S.W. 1.

(6) "Swift" carbon tetrachloride extinguisher for motor car and electric fires.

*Lent by*—BLAKEBOROUGH, Ltd., Brighouse.

(7) "Essex" methyl bromide extinguishers, suitable for highly nflammable liquids like petrol and carbon disulphide.

*Lent by*—THE NATIONAL FIRE PROTECTION Co., Ltd., Petersham Road, Richmond.

## "Ajax" Turntable Hose Reel.

This can be worked single-handed by a woman or a girl. It swings easily in any direction and water flows freely through the hose no matter how much, or how little, has been unreeled.

*Lent by*—JOHN MORRIS & SONS, Ltd., Salford Fire Engine Works, Manchester.

## Hand Pumps.

A bucket hand pump is a most efficient appliance and can be kept at work so long as water can be brought to the cistern. It is very much more than a "first aid" appliance and can deal with a fire of some magnitude. Filled buckets should be kept near the appliance. "*Corridor pumps*" mounted on wheels are of similar construction, but hold more water and are slightly more powerful.

*Examples lent by*—

JOHN MORRIS & SONS, Ltd., Salford.
MERRYWEATHER & SONS, London.

## Automatic Sprinkler.

The installation of such a sprinkler is one of the greatest safeguards against fire. There are many cases on record where fires which would almost certainly have proved serious have been checked in their inception by the operation of sprinklers. Where highly inflammable materials are handled, or in such places as joiners' shops, pattern shops, woodworking shops generally, cotton mills, flour mills, and elsewhere where there are specially dangerous risks, the value of a sprinkler installation is shown by the fact that insurance premiums are reduced as much as 50 per cent. where such plant is installed. In London, where, under the Building Acts, certain limits are imposed on the cubic capacity of buildings of the warehouse class, the limits are often considerably extended when the premises are protected by automatic sprinklers.

*Lent by*—MATHER & PLATT, Ltd., Manchester.

## Inside Hydrant Installation

Showing satisfactory method of mounting hose to prevent deterioration, allow quick release in emergency, etc. The hose and couplings are $1\frac{1}{2}$ in. in diameter. Where, as in the Museum installation, the hydrant valve is of standard diameter ($2\frac{1}{2}$ in.), a reducing adaptor can be fitted to it to enable use of the smaller diameter hose, which for most risks will be found more suitable. It is easily handled, even by a woman, damage by water is reduced and cost of installation is less.

*Lent by*—H.M. OFFICE OF WORKS.

*Quick release hose buckle.*

*Lent by*—MERRYWEATHER & SONS, Greenwich Road, S.E.10.

## Couplings.

Samples of the three types of coupling in most general use in the country are shown. These are, the "Instantaneous," the "Round Thread Screw," and the "V Thread Screw."

*Lent by*—JOHN MORRIS & SONS, Ltd., Salford.

## Standard Adaptor.

The provision of such an adaptor will enable brigades to couple up to hydrants, pumps or hose of any other brigade or factory, no matter what coupling is in use by either party, provided both are equipped with this adaptor.

*Lent by*—NUNAN & STOVE, Ltd., Glasgow.

Two examples of adaptors incorporating the "Morris" instantaneous coupling are also shown.

## Hand Control Branch Pipe.

This enables the operator to control the jet, and provides him with a protecting water curtain and smoke driving spray.

*Lent by*—JOHN MORRIS & SONS, Salford.

## Light Fire Ladder.

Strong, but readily handled.

*Lent by*—MERRYWEATHER & SONS, Greenwich Road, S.E.10.

## Hand Axe.

Of tomahawk pattern and strongly designed, for cutting away match-boarding, flooring, etc., in order to get at seat of fire.

*Lent by*—THE GENERAL FIRE APPLIANCE Co., 11, Queen Victoria Street, E.C.4.

## Life Line Wound on Leather Bobbin.

A line made up in this way will pay out clear when thrown down from aloft. The bobbin assists the line to travel over a sloping roof or to pass obstructions. The end of the line can be easily found by men on the ground. The line is carried over a man's shoulder by means of the loop in the free end.

*Lent by*—THE GENERAL FIRE APPLIANCE Co., 11, Queen Victoria Street, E.C.4.

## Petrol Cleaning Tank.

The use of petrol in pails, tins or trays for cleaning parts of machines, etc., has been the cause of many serious fires due to the splashing of floors or an overturned pail. This tank has been designed to minimise this risk.

The apparatus consists of a tank with a perforated base, and under this a sump with a gauze filter is fitted. An external pedal operates a semi-rotary pump which draws the petrol from the sump and forces it out of a nozzle on the flexible hose.

The machine parts to be cleaned are placed in the tank and sprayed with petrol. The lid reduces splashing to a minimum and the petrol, after passing through the filter, returns to the sump to be re-used.

*Lent by*—MANN, EGERTON & Co., Ltd., Norwich.

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## PHOTOGRAPHS.

On Screen XXXIV and the table are shown drawings and photographs of types of hydrant, motor pumps, rescue apparatus, etc., and of the damage done by fires at various factories.

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See also account of the " fire " arrangements for the Museum in the description of the Museum Building (page 9).

## Fire Occurrence Book (In Case).

The use of an " Occurrence Book " in which all tests and inspections of fire appliances, overhauls and repairs, fire drills and fire practices, and all matters connected with fire prevention, are required to be entered by the person or persons responsible, is a valuable aid to the maintenance of a high standard of protection. It ensures that the routine laid down by the management is strictly followed out and that the general manager is kept informed of everything that happens. The book should be kept in the general manager's room, and preferably in a case. If kept in a drawer, it is liable to be overlooked or forgotten.

Actual outbreaks of fire should be entered in the book in red ink.

An example is shown of such a book (in case), with a month's typical entries for a factory with a permanent fire superintendent and a brigade of auxiliaries, one sprinkler installation, both inside and outside hydrants, and first aid and reinforcing first aid appliances.

*Reference :—*
Home Office Safety Pamphlet No. 13, Fire Protection in Factories.

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# EYE ACCIDENTS.

## (Case U—Screen XXXIII.)

The number of accidents to the eyes which occur in premises under the Factory Acts is very large.

During the five years 1928–32 the number amounted to 28,934, an average of more than 5,700 a year. Nine ended fatally.

The following table shows the industries in which the greater number of these accidents occur :—

| | 1932. | 1931. | 1930. | 1929. | 1928. |
|---|---|---|---|---|---|
| Metal founding .. .. | 466 | 502 | 658 | 829 | 734 |
| Shipbuilding .. .. | 232 | 315 | 696 | 670 | 691 |
| Railway, and motor vehicles. | 492 | 529 | 623 | 635 | 657 |
| Metal conversion, including rolling mills and tube making. | 342 | 317 | 450 | 550 | 605 |
| Engine and locomotive building. | 276 | 337 | 490 | 544 | 538 |
| Machine making .. .. | 368 | 397 | 487 | 442 | 493 |
| Light metal trades.. .. | 273 | 270 | 352 | 371 | 342 |
| Boiler making and constructional engineering. | 133 | 171 | 230 | 236 | 261 |
| Electrical engineering .. | 191 | 191 | 267 | 240 | 221 |
| Ordnance and munitions .. | 61 | 65 | 81 | 95 | 94 |
| Chemicals, paints, etc. .. | 265 | 229 | 326 | 291 | 322 |

The particular processes mainly responsible are :—

(*a*) grinding, glazing and polishing of metal articles ;
(*b*) pouring, stirring and carrying molten metal ;
(*c*) riveting, caulking, scaling, and cutting out rivets ;
(*d*) dressing or fettling castings ;
(*e*) chipping and filing metal articles (both with hand and pneumatic tools) ;
(*f*) smithing, including work at power hammers, drop stamps, forging machines, etc. ;
(*g*) metal working by machinery—lathes, drilling and milling machines, etc. ;
(*h*) stone dressing ;
(*i*) chemical processes.

It would seem that the obvious remedy against these accidents would be the wearing of goggles by the worker. For some processes (e.g., in the chemical industry) the provision and use of goggles are made compulsory, and in a number of other processes they have been introduced by voluntary action on the part of the employers, or adopted by the workers themselves. The present exhibit includes goggles which have been actually in use, and which are heavily pitted or fractured by particles which but for them would have struck the eye of the worker. A number of these are supplied by the Great Western Railway Company from their works at Swindon, where they were introduced and their use enforced by the management.

Many employers, however, have experienced great difficulty in inducing their workers to wear the goggles when provided. There are several reasons for this. The goggles supplied have often been badly designed so that they do not fit the worker and are uncomfortable to wear ; or they have no ventilation and are hot to wear and the glasses fog or restrict the worker's vision too much ; or the particular operation, e.g., sharpening a tool, may only be done at irregular intervals.

These difficulties are not insuperable, at any rate in many cases. Different designs suit different processes and care is needed in selecting a suitable design for the work.

The exhibit shows various types which can be recommended.

There is another and alternative remedy which, where it can be adopted, has a decided advantage over goggles. This is the provision of an adjustable transparent screen between the worker and his work. These are being adopted in a number of works, and photographs of some are shown (Screen XXXIII). The provision of such screens is strongly recommended for the consideration of employers, and the following experience of the London General Omnibus Company which may be taken as typical is noteworthy. The Company consulted the Home Office as to their eye accidents in connection with the emery grinding wheels at their Chiswick works, and the difficulty experienced in enforcing the use of goggles. The use of an adjustable celluloid screen was recommended and adopted in October, 1926 ; and the Company, writing in August, 1927, reported that whereas in the 12 months preceding the adoption of the screens, 68 accidents had occurred, there had been no accidents since, when the guard had been properly used and adjusted. Photographs of this screen and of other screens as used at different works will be found on Screen XXXIII. Celluloid and " Triplex " Screens are also shown fitted to the abrasive wheels on the double-headed grinding machine on Ground Floor.

# HAND TOOLS.

## (Case V.)

Even in this age of machinery, many industrial operations are still performed mainly by the use of hand tools, and the reports to the Factory Department show that hand tools are responsible for a large number of industrial accidents. During the four years, 1929–32, 53 persons were killed and 50,870 were injured by accidents of this kind. The risks with hand tools are less apparent, and for this reason less recognised, than the risks with machines, and this, no doubt, is one reason why accidents often occur in their use. Such accidents are due mainly to :—

1. Use of tools of unsuitable material.
2. Handles badly secured or of unsuitable material, size or shape.
3. Mishandling of tools due to carelessness or lack of skill.
4. Failure to maintain tools and handles in proper condition.
5. Slipping of the tool.
6. Leaving tools where persons are liable to come into contact with their sharp edges, or where the tools are liable to fall on other workers.

### Handles.

Wooden handles, which are generally used, should be :—

1. Made of the best straight-grained material.
2. Suitable in shape, of adequate size and fitted squarely to the tools.
3. Secured in a proper manner to the tools.
4. Frequently examined for splits or other defects.
5. Replaced or repaired when defective.

Unsuitable wood readily splinters or splits and is a common cause of lacerated hands and septic wounds. A badly shaped handle often causes blisters and muscular cramp.

A handle which is too small cannot be gripped properly and a hammer fitted with such a handle is liable to fly out of the hand and cause injury. A file or scraper handle which is too small is more liable to split than one of the right size and as a result the worker's hand may be penetrated by the tang. Handles which are not secured squarely to the tool interfere with the proper use of the tool and, in the case of hammers, are liable to cause glancing blows when a chisel or tool is being struck and result in injury to the hand.

Hammer heads improperly secured to the handles are liable to fly off and to cause serious injuries. These heads are best secured by means of properly shaped and glued wooden wedges, as metal wedges are more liable to become loose through the wood of the handle drying and shrinking. The use of nails for securing hammer heads should be absolutely forbidden.

The handles of wood-cutting chisels and files should always be fitted with metal ferrules as these minimise the risk of the wood splitting, and also help to secure the tang in the handle.

Specimens are shown of unsuitable, badly secured and split handles.

## Accidents due to Slipping of Tool.

Accidents are caused by the slipping of such a tool as a punch in the hand of a worker. This risk may be avoided by milling or knurling the shank. Specimens of punches with such shanks are exhibited. Butchers' knives, which are used by persons employed in food factories when sticking and cutting meat, are liable to slip in the hand and inflict serious cuts. This risk can be minimised by notching the handle or fitting a stop or guard.

Another class of accident arises from the slipping of hand tools on the work. In the case of hammers, this may be due to the use of an unsuitable type or weight of hammer, or to lack of balance or straightness in the handle. Hammers with corrugated driving faces are sometimes used by box and case makers as such hammers prevent the nails from flying when struck.

Spanners and wrenches are also liable to slip on the work, especially when the jaws are unduly strained or spread. Adjustable spanners with badly worn threads resulting in loose jaws, and pipe wrenches with worn teeth, are also causes of accidents. The slipping of a spanner or wrench when in use by a worker on a stage or scaffold may cause him to fall and sustain fatal injuries.

Screwdrivers should be used of a size suitable to the slots of the screws and with properly shaped heads to prevent slipping.

Accidents due to slipping of the knife blade when cutting meat can be largely avoided by the use of forks with strong metal guards.

Specimens are shown of badly worn spanners and wrenches; also butchers' knives and forks with safe types of handles.

## Materials and Maintenance.

The materials for tools should be carefully chosen with reference to the nature of the work on which they are to be used. Chisels, punches, etc., made from unsuitable material soon become dull and their heads mushroomed and cracked. Fragments of steel are liable to fly from mushroomed heads when these are struck and are a fruitful cause of injury, especially to the eye. Such heads should therefore be ground off or otherwise removed.

The exhibit comprises samples of defective tools which were found in use in works.

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# BELT FASTENINGS OR JOINTS.

## (Case Y.)

When a belt fastening or joint fails, workers are liable to be struck by the flying ends of the belt or by pieces of the fasteners, which may be thrown off with great force. As complete enclosure or fencing of all belts *so as to intercept a flying end or fastener* is impracticable, the importance of attention to the fastenings is evident.

The following are some causes of failure of belt joints :—

(1) Use of unsatisfactory methods—

(*a*) A common type consists of a small malleable iron plate with short teeth projecting. This is unsuitable for fabric belts because of the difficulty of properly clinching the teeth and also because of the lack of flexibility. For leather belts transmitting low power on simple slow-speed drives, it is not so objectionable.

(*b*) Leather belts are sometimes jointed by tapering the ends to form a lap and inserting numerous tin-tacks, the spikes of which are clinched by hammering them against a hard surface. A crude method.

(2) Excessive strain and consequent distortion on one side of the joint due to the butt ends of the belt not having been cut exactly at right angles to the length of the belt.

(3) Use of fasteners too small or too light for the duty that the belt is required to perform ; with the result that the clinching of the teeth or spikes is inadequate. This is specially serious with twisted drives.

(4) Making the holes for the joints in the belt larger than necessary and thus weakening the belt by reducing its cross section.

(5) Vibration causing the nuts or buttons of certain types of fasteners to work loose and fall off.

(6) Wearing away of the part of the fastener in contact with the faces of the pulleys.

(7) Softening of " balata " belting, with consequent pulling out of the fasteners, or failure of the jointing solution—due to heat. A " balata " belt is not reliable if exposed to a temperature above 120° Fahr.

(8) Corrosion and weakening of parts of metallic fasteners due to the action of chemical fumes or moisture.

The exhibit shows various types of belt fasteners, which are found to be satisfactory *provided* care is taken to see that the fasteners are properly applied. A *weekly* examination of the fasteners of all high-speed belts on twisted drives or of belts running under abnormal conditions, is strongly recommended.

# SAFETY FIRST.

*" ' Safety First ' Organisation.—Another important point that emerges again this year is the comparatively small proportion of accidents that are due to unfenced machinery. Out of the total of* 139,963 *accidents reported, only* 34,833 *were machinery accidents, the remaining* 105,130 *had nothing to do with machinery at all. This is a significant fact which is too often overlooked. Everyone is inclined to think of accidents in terms of machinery, and while no one would wish to under-rate the importance of providing adequate fencing for machinery, it is evident that if a substantial reduction of the annual total of accidents is to be brought about, means must be found for dealing with these non-machinery cases, which for the most part are due to some failure of the human machine. They are sometimes wrongly regarded as the inevitable accompaniment of large-scale industry. Experience shows that this is not the case : on the contrary, there is now abundant evidence that with proper organisation on what has come to be known as ' Safety First ' lines, their number can be enormously reduced.*

*" It has been the work of the inspectors, therefore, during the past few years to do everything in their power to stimulate activity in this direction, but it has to be admitted that their efforts have been attended with but very moderate success, and they have found it curiously difficult to arouse interest amongst either employers or workers. Progress in the establishment of safety organisations has, in fact, been disappointingly slow."*—Extract from Report of the Chief Inspector of Factories for 1926.

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The exhibit illustrates methods actually adopted and results obtained in works in this country. It is necessarily limited in scope, both because comparatively few firms in this country have so far adopted organised safety schemes, and because the methods do not readily lend themselves to exhibition. The exhibits include :—

(1) *Chart* showing savings in accident compensation effected by the establishment of safety schemes—based on figures supplied by certain large firms and by an insurance company covering both large and small firms. (Screen VII.)

(2) *" Safety First " Posters and " Slogans "* issued by the National Safety First Association, National Employers' Mutual Insurance Association and individual firms. (On easels.)

(3) *Warning Notices* used by particular firms. (Screen VII.)

(4) *Safety Committees' Reports.*—Sample reports of investigations into accidents. (Screens VII and VIII.)

(5) *Safety Competitions* between different departments or sections of works. Particulars supplied by Thames Board Mills, Ltd. (Screen VII.)

(6) *Leaflets* issued by various firms describing their safety arrangements, accident records, etc.

(7) Photographs illustrating use of marked gangways and storage space, and works display of safety notices. (Screens VII and VIII.)

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Certain of the exhibits in the Health and Welfare Section of the Museum have a bearing on safety, e.g. :—

Protective Clothing for Foundry Work, Aerated Water Manufacture, etc.

Lighting—*see* Lighting Exhibit in Basement.

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## LABOUR SAVING.

The application of labour-saving principles to industry is an important means of reducing the risk of accident and injury to health, as well as increasing output and lessening the cost of production. Injuries through strains or falls while lifting or carrying heavy weights, etc., are eliminated and time and energy are saved.

The application of labour-saving principles to industry is not confined to the use of particular labour-saving or labour-aiding devices and appliances, but extends to the lay-out of the factory and arrangement of the work. A considerable development has taken place during recent years in this direction, partly as a result of the reorganisation necessitated by the war, and partly as a result of increasing mass production, and many modern factories afford excellent examples of successful planning to minimise the amount of handling of both raw and finished materials

While the introduction of labour-saving methods on the complete scale is easier in the case of new factories, they are also being increasingly adopted in the older factories.

Some of the principal types of labour-saving devices found in use are as follows :—Pulley blocks (especially geared and self-sustaining types), overhead runways, self-landing and delivering hoists, electric trolley or mono-rail hoists, electric and petrol-electric run-about cranes, electric trucks, ropeways and telphers, conveyors, gravity roller runways and shutes, stacking machines, jack trucks and hand elevators.

Owing to limitations of space it is not possible to exhibit many of these appliances except by means of photographs. A number of these are shown on Screen IX and a revolving stand against the wall, and illustrate the application of many of the above-mentioned appliances in various industries.

The actual appliances shown are different types of lifter trucks and a hand carrier for a Winchester containing acid. These are all described in the notices attached to them. A beam truck used in the textile industries for moving and lifting the heavy warp beams is shown with the Textile Machinery Exhibit on the Ground Floor.

*Reference :*

Report of Chief Inspector of Factories for 1926 (Chap. III).

## Features of Work Benches.

Experience shows that the arrangements at benches for packing, assembly and similar work are of great importance in preventing fatigue and promoting easy, rapid and satisfactory work. Near the Silicosis exhibit is a table which has been designed to illustrate features, which have been adopted in various factories with valuable results. Attention is drawn to the following points :—

(1) The *height* of table, so that work can be done comfortably either standing or sitting. The height in this case is 3 ft. 2 in.
(2) The *shape* of table to promote comfort and ready access to work, etc.
(3) The *slope* of table ; this may with advantage be made adjustable.
(4) Adequate *space* for knees of workers when sitting.
(5) *Trays*, or other arrangements, for placing materials, tools, etc., in convenient and secure positions.
(6) *Arm Rests.*
(7) *Seats*, adjustable or otherwise, designed to suit the work and the operative. (*See also* " Seats for Workers," page 149.)
(8) *Foot Rests* of suitable shape and height.

# WEIGHT LIFTING AND CARRYING IN RELATION TO ACCIDENTS AND FATIGUE.

In spite of modern tendency to replace manual methods by mechanical means, the handling of heavy weights forms a large part of the general work in some industries, while there are few factories in which there is not some lifting and carrying of loads.

The question is of importance in industry, both from the point of view of accident prevention and of reducing fatigue. A recent study of the question by the Factory Department showed that in the three months, February to April, 1929, 948 accidents from weight lifting were reported to the Inspectors. The accidents resulted mostly in muscular strains and hernia, and occurred, as might be expected, mainly to men.

Loss of balance is the commonest cause ; and it is not difficult to realise how easily this may occur and how serious may be the injuries when the load is equal to or greater than the worker's body weight. A rough standard is that for men the load should not exceed the body weight of the worker ; for women it should not exceed 50 per cent. of the body weight for occasional work or 40 per cent. for continuous work ; for growing boys and girls the proportion should be less. But the weight carried is not the only matter to be considered ; the mode of lifting or carrying is hardly less important.

Traditional methods of carrying weights are found in many instances to be endorsed by the knowledge gained by scientific research. Not all traditional methods, however, are the best possible ; and research has been able not only to correct methods that are wrong, but also to calculate the loss in energy caused by the use of such methods.

The exhibit has been devised to illustrate good and bad methods of lifting and carrying weights. The physical cost of weight lifting to the body is found to vary directly with—

(1) interference with normal gait,
(2) disturbance of the centre of gravity,
(3) interference with breathing by cramping the chest.

A case containing a number of statuettes is on view some of which illustrate good methods of carrying various types of load by means which cause the least interference with natural movements. Others show how bad methods cause cramping and distortion of the body and loss of energy.

Safe and dangerous methods of lifting and carrying various types of load are also shown in the drawings on screen VIIIB. Mechanical means of trucking and lifting loads are illustrated in the adjacent Labour Saving exhibit.

*References :—*

(i) Woollen and Worsted Textiles (Lifting of Heavy Weights) Regulations, 1926. (S.R. and O. 1463).

(ii) Pottery Regulations, 1913 (S.R. and O.2), Reg. 1 (*b*), (*c*), (*m*).

(iii) Annual Reports of Chief Inspector of Factories, 1925 and 1929.

(iv) Reports Nos. 29, 44, 50 of the Industrial Health Research Board.

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## CHEMICAL WORKS.

At the moment the exhibit consists only of photographs. Fencing of platforms and passage ways are shown ; provision for water drench in case of acid burn, and greasy pole method of escape from upper levels in case of fire.

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PART III.

HEALTH AND WELFARE.

*GALLERY.*

# APPARATUS USED FOR ASCERTAINING ATMOSPHERIC CONDITIONS IN FACTORIES.

*IN CASE W.*

*Anemometers* (two sizes) for determining the speed of air currents, produced by fans or otherwise.

*Pitot Tube,* required for the more correct determination of fan outputs, than is possible by the anemometer. The pressure in the fan ducts is measured by the difference of level produced in an ordinary U-tube or manometer gauge, to which the two branches of the Pitot tube are connected.

(*A Manometer,* for measuring static air pressure in ducts, etc., is shown in the grinding section on ground floor).

*Hygrometers,* for determining the relative humidity or degree of saturation of the air. Their use is required by the Factory Act or Home Office Regulations in some branches of the textile industry, in which artificial humidity is used to assist the carrying on of the process, for the purpose of ensuring that the amount of humidity is kept within the limits prescribed. Four types are shown, three of the ordinary wet and dry bulb type, and one of the whirling psychrometer type used for rapid determinations.

*Katathermometers,* for determining the cooling power of the air in a workroom. *See* detailed description on page 185.

*Dr. J. S. Owens' Jet Dust Counter.*—An apparatus for collecting dust suspended in the atmosphere, so that the particles can be examined and counted under the microscope and the number of particles in a given volume of air calculated. A sample of the air to be tested is drawn by a pump with a capacity of 50 c.c., through a cylinder lined with damp blotting paper to a slot through which it passes as a very fine jet and impinges at a high velocity on a microscope cover-glass, to which the solid particles adhere. The cover-glass can be mounted on a microscope slide to form a permanent specimen.

Very fine particles which may be invisible to the naked eye, though present in the atmosphere in enormous numbers, can be collected with

this apparatus, which is therefore specially useful in determining the amount of dust present in workrooms where processes giving rise to certain dangerous kinds of fine dust, such as silica dust, are carried on.

Microphotographs of specimens of atmospheric dust taken with the apparatus are shown in an album in the Silicosis exhibit in the Industrial Diseases Section.

*Dust Counter lent by—*
C. F. CASELLA & Co., Ltd., Regent House, Southampton Street, W.1.

*Katathermometers lent by—*
J. J. HICKS, 8, Hatton Garden, London.

*Ivor Graham Carbon Monoxide Apparatus,* for determination of the presence of small quantities of CO in the air.

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*See also* " Air Conditioning Plant," page 187.

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## BREATHING APPARATUS.

## GASSING—RESCUE APPARATUS.

A number of cases occur every year in which persons engaged in cleaning, repairing or other work inside tanks, chambers and other receptacles are overcome by gas, often with fatal results. This danger has already led in the case of chemical works to regulations being laid down which require certain precautions to be taken; but the same danger arises in many other classes of works, e.g., in steel and iron works (flues and furnace chambers, etc., the air of which may contain a high percentage of carbon monoxide gas), breweries (vats containing carbon dioxide gas from fermentation), cement works (kilns containing carbon monoxide gas from fires), indiarubber works (tanks containing naphtha, carbon bisulphide

and other solvents). In fact, the dangers are liable to arise in any works where gases are generated or used, or volatile liquids such as benzol, naphtha, carbon bisulphide are stored or used. The risk is incurred not only by the person engaged in the work but also by any person who has to enter the tank, chamber or receptacle to rescue him in the event of his becoming gassed. Lives are frequently lost in the course of rescue operations.

In the five years 1927–31, 795 cases of gassing were reported to the Factory Department, resulting in 71 deaths. Of these, 439 (causing 45 deaths) were due to carbon monoxide. The danger from gassing by carbon monoxide is present in any industry in which coal gas or producer gas is used for power, heating or other purposes.

In all places where gas is liable to be present, work should be strictly prohibited unless either the worker is provided with a suitable type of breathing apparatus, or efficient means have been taken to remove any dangerous gas from the tank, chamber or receptacle and the air has been tested and found by a responsible person appointed by the manager to be free from gas ; but if suitable breathing apparatus is not worn, no person should be allowed to enter the tank, chamber or receptacle except with a life line, which is held by a person outside. For testing the air, small animals, such as mice, may be used and kept at the factory for the purpose : alternatively, samples of the air should be taken and analysed.

THE EXHIBIT includes various types of breathing apparatus for use under the conditions mentioned and in rescue operations :—

(1) *" Proto " self-contained oxygen breathing apparatus* (2-hour type).

(2) *" Salvus " self-contained oxygen breathing apparatus* ($\frac{1}{2}$-hour type).

Types (1) and (2) have been approved by the Home Office under the Chemical Works Regulations, 1922, for chemical works. They are for use *only* by specially trained men.

(3) *Smoke helmet with air tube and bellows* for work in smoke fumes and other noxious atmospheres at a short distance only from the fresh air.

(4) *" Antipoys " short-distance breathing apparatus,* consisting of face mask and short length of specially designed tubing leading to air supply and fitted with a valve arrangement. The eye-pieces of the mask are kept clear of moisture by conducting the cool fresh air across them.

Types (3) and (4) are types of apparatus for enabling a person working in a dangerous atmosphere to breathe ordinary air.

(5) *" Puretha " canister or army type of respirator.*—This type is very convenient for use in circumstances in which the use of a helmet and tube or a self-contained type of breathing apparatus would be inconvenient and cumbersome. But its effectiveness is limited. Different containers are required for different kinds of gas, and the apparatus is *not suitable for use in confined spaces such as stills, tanks, etc., or in any circumstances where carbon monoxide or a highly concentrated gas is liable to be present.* The user should be thoroughly trained in its use. This type has been approved for use in chemical works under the Home Office Regulations, subject to certain conditions.

(6) *Safety belt.*—Designed to comply with Home Office Regulations as to provision of life belts in chemical works, and intended for use by persons working in places where there is risk of gassing and by persons engaged in rescue. The wristlet with eye through which the life-line can be passed is useful if the wearer has to be drawn up through a narrow manhole. The arm is drawn up and pulled through before the head and rest of body, which will then follow without difficulty.

(7) *" Novita " oxygen resuscitating apparatus* for restoring persons who have been partly asphyxiated or drowned.

(8) *" Novox " apparatus,* for administering " Dicarbox " gas (oxygen and 5 per cent. of carbon dioxide) to persons suffering from carbon monoxide poisoning, oxygen want, etc.

*The Exhibit lent by*—SIEBE GORMAN & Co., London.

(9) *" Sparklet Pocket Resuscitator."*

*Lent by*—SPARKLETS, Ltd., Upper Edmonton, N.18.

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## RESPIRATORS.
### (Case A.)

Respirators, as distinct from " Breathing Apparatus," are designed to protect the wearer from the inhalation of coarse or moderately coarse dusts. *They are of no service as a protection against gases, poisonous fumes, smoke, or very fine dust.*

The efficiency of a respirator depends, in the first place, upon the power of the filtering medium to remove the injurious particles from the air as it passes through the medium. On the other hand, a material having a high filtering power may oppose considerable resistance to breathing. The object, therefore, in designing a respirator is to obtain a medium which will combine a high filtering power with low resistance to breathing. Several layers of a thin material may have better filtering power than a single layer of thick material, and at the same time oppose less resistance to breathing. For example, in tests made in the United States against silica dust in air (filter area, 100 square centimetres ; rate of air flow, 10 litres per minute), it was found that :—

16 plies of cheese-cloth removed 45 per cent. of the dust with 0·4 in. resistance.

2 plies of unbleached muslin removed 24 per cent. of the dust with 0·6 in. resistance.

1 ply of Canton flannel removed 10 per cent. of the dust with 0·6 in. resistance.

When the respirator has been in use for some time the air spaces of the filtering medium tend to become blocked with particles of dust. This condition, though it increases the filtering power, also makes the medium more difficult to breathe through. Thus, in the test noted above with Canton flannel, the efficiency reached 100 per cent. in $2\frac{1}{6}$ minutes and the resistance rose to 2·4 in. For continuous working use, resistance should not exceed 2 in. and preferably should be less than 1 in. Increased resistance is produced more readily in respirators in which the expired air passes through the medium and makes it moist, and an expiratory valve which avoids this is desirable.

If the filtering medium is allowed to become more or less choked and offers resistance to the breathing, the air may pass between the edge of the respirator and the face instead of through the medium. To avoid this cause of failure, the edges of the respirator should fit closely to the face, and the filtering medium should be cleansed or renewed at frequent intervals. Respirators constructed of rigid material may be provided with a pneumatic rim, which will permit of their close application to the face with comfort.

Some woven fabrics may lose their filtering power after washing.

To guard against the risk of communicable disease, each worker should have his own respirator and interchange should not be permitted unless every part of the respirator has been thoroughly cleansed with a disinfectant.

Various types of respirator are shown (Case A) :—

1 (*a*). *" Pulva-Filter " dust respirator*—complete mask with goggles. This type presents large surface of filtering material and moisture from expired air does not come in contact with filtering medium. Suitable for occasional, not for regular, use.

1 (*b*). *" Pulv-Filta " dust respirator*—half mask. Similar to 1 (*a*), but does not protect the eyes.

2 (*a*). *Sponge respirator,* with expiratory valve. Body of respirator of vulcanised indiarubber—easily washed.

2 (*b*). *Sponge respirator.*—Similar to 2 (*a*), but with removable ebonite front piece.

2 (*c*). *Sponge respirator,* with metal body, detachable sponge-chamber, pneumatic rim to ensure close fitting to face.

2 (*d*). *Sponge respirator,* with brass body and felt rim.

2 (*e*). *Sponge respirator,* with strip of flexible aluminium in upper parts, enabling it to be shaped to the nose.

2 (*f*). *Sponge respirator,* with aluminium body. Cushion rim. Removable front piece containing metal gauze.

3. *Dust mask with celluloid goggles.*—Outer surface waterproof and filtering material of towelling. Entire mask can be cleansed.

4 (*a*), 4 (*b*) and 4 (*c*). *Aluminium respirators.*—Filtering medium is a thin layer of cotton wool. Expiratory valve at top and rubber binding at edge.

5 (*a*). *Dust filter or respirator,* consisting of double layer of cellular netting with cotton wool pad between. Netting can be washed and cotton wool renewed.

5 (*b*). *Flannel respirator.*—This type, like 3, 4 and 5(*a*), has the disadvantage that moisture from the expired air tends to produce blocking of the filtering material with particles of dust.

5 (*c*). *Cotton wool tissue,* which can be varied in thickness, is held in position against nose and mouth by specially shaped metal frame.

6. *Cotton wool respirator.*—Cotton wool is contained in chamber in front : body is of rubberised canvas with expiratory valve.

7. *" Lane " dust respirator,* filtering medium felt pads. Facepiece has inturned " feather edge " which is drawn firmly on the face on inspiration.

*Exhibits Nos.* 1 (*a*), 1 (*b*), 2 (*a*), 2 (*b*), 2 (*c*), 3, 4 (*a*), 5 (*a*), 5 (*b*), 7.

*Lent by*—SIEBE GORMAN & Co., Ltd., London.

*Exhibit No.* 2 (*f*).

*Lent by*—WM. STEPHENS & SONS, Ltd., Wood Green, N.22.

*Exhibits Nos.* 2 (*d*), 2 (*e*), and 4 (*b*).

*Lent by*—THE MENTOR SAFETY APPLIANCES Co., 12, City Road, E.C.1.

*Exhibits Nos.* 4 (*c*) and 6.

*Lent by*—WALLACH BROS., Ltd., 49, Tabernacle St., E.C.2.

*Exhibit No.* 5 (*c*).

*Lent by*—KEELING & WALKER, Ltd., Stoke-on-Trent.

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## ANTHRAX.

Anthrax is contracted by industrial workers through contact with infected material or inhaling or swallowing dust from infected material. The disease is one to which the lower animals are liable over wide districts throughout the whole world, and the infected material which finds its way into industry consists mainly of animal products from specially infected areas (other materials may become infected through contact, as cargo, with animal products). When an animal dies from the disease, the flesh, bone, skin, wool, hair, and hoofs are, or may become infected with the specific organism which causes the disease (anthrax bacillus), and a characteristic feature of the organism, to which it owes much of its danger, is that it possesses the property on exposure to air of forming spores which are difficult to destroy and are capable of surviving for many years. Moreover, the organism develops in the blood and is thus in association with the albumen of the blood which serves to fasten the spores to the fibres of the wool or hair of the animal—though it may be quite impossible to detect the presence of blood either visually or chemically. When infected wool or hair is being manipulated in the course of manufacture or even when being handled, the spores are liable to become detached and may find their way into the blood of the worker through the skin or through the nose or mouth.

It is possible to determine by bacteriological examination whether or not a sample of material is infected with the spores of anthrax, and the examination of a sufficient number of samples of wool and hair will show from what countries or districts the materials come which are likely to convey infection to industrial workers and call for special measures of precaution.

Wax models showing the appearance of anthrax on the skin are shown in Case F1.

## Disinfection of Wool and Hair.

The Home Office Committee on Anthrax (1918) recommended that "the policy of attempting to control the danger of anthrax in wool by Regulations under the Factory Act should be abandoned and instead the principle of compulsory disinfection substituted." The necessary powers to carry this recommendation into effect were given by Parliament in 1919 (Anthrax Prevention Act, 9 and 10 Geo. 5, Ch. 23), and in 1921 a Government Disinfecting Station was opened at Liverpool (the chief port of import) in a convenient position on the premises of the Mersey Docks and Harbour Board, to apply the method of disinfection which had been devised by the Committee.

The materials at present scheduled for compulsory disinfection under the Anthrax Order-in-Council (S.R. & O., 1921, No. 352) are "all goat hair produced in or exported from or through India, and all wool and animal hair produced in or exported from or through Egypt, including the Anglo-Egyptian Sudan, and all goods mixed therewith." These categories do not cover all the classes of material which are liable to be infected with anthrax, and certain types of material (chiefly wool and goat hair) are submitted voluntarily by some manufacturers to the Station for disinfection.

The process of disinfection consists of :—

(1) Preliminary treatment to remove the protective albuminous covering from the anthrax spores and to make their destruction easy ;

(2) Actual disinfection, in which the spores are destroyed ; and

(3) Drying.

The whole of the disinfecting plant is shown in the photograph of the Station and described in the notes attached.

In order to safeguard the staff of the Disinfecting Station as much as possible against the risk of infection, the whole process is automatic and the only manual operations required are taking the covers off the bales before disinfection and putting new covers and bands on the bales after completion of the process.

*To face p. 133.*


INDUSTRIAL DISEASES SECTION.

Lead Poisoning, Silicosis, Asbestosis and Dermatitis exhibits. Cases containing wax models of diseases. Lead dross boxes in front of cases. X-ray photographs in cases under window.

Material takes 90 to 100 minutes to pass through the machine.

For results of the bacteriological examinations of material disinfected at the Station, *see* the Table exhibited on Screen VIIIA.

The Station is run immediately under the Home Office by a Director appointed from the Factory Inspectorate, and the Home Office is assisted in the administration of the scheme by an Advisory Committee.

Specimens of material before and after disinfection, and of material disinfected and not disinfected, at various stages of manufacture, are shown in Cases A1, B1, C1, D1, E1, F1.

The charges made for disinfection depend upon the weight and to some extent on the character of the material.

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## LEAD POISONING.

### Causation.

Industrial lead poisoning is almost always the result of inhalation of dust or fume, or of absorption from the alimentary tract.

### Occurrence.

The following are the chief industries in which lead poisoning occurs and the main sources of poisoning :—

(1) *Smelting of Metals*—(a) *Lead Smelting and Desilverising.*—Fume and dust at the blasting and refining furnaces, and fume given off by the cupola. (b) *Spelter* (*zinc manufacture*).—Fume given off in the distillation of the charge.

(2) *Manufacture of White Lead.*—Dust of the dross from the molten metal in the manufacture of the wickets ; dust in emptying the stacks ; dust in handling the corrosions ; dust from the drying stoves ; dust produced in grinding and packing dry white lead.

(3) *Manufacture of Red Lead.*—Dust from the furnaces and in packing.

(4) *Plumbing and Soldering.*—Handling red and white lead for jointing, and lead burning with an oxy-hydrogen or oxy-acetylene blow pipe flame.

(5) *Shipbreaking.*—Fume given off from the lead-painted plates when cut by the high temperature oxy-acetylene flame.

(6) *Manufacture of Pottery.*—Dust and splashing in the processes of dipping, ware cleaning, aerographing, etc.

(7) *Enamelling.*—Dust in dusting on the glaze.

(8) *Manufacture of Electric Accumulators.*—Dust of the dross from the molten metal in casting grids ; dust of lead oxide in mixing and in pasting ; fume from lead burning ; dust of the oxide in trimming, filing, etc. ; fume and dust from melting and handling old plates.

(9) *Printing.*—Dust in the type cases. Drossing molten metal.

(10) *Manufacture of Indiarubber.*—Dust in the mixing of lead oxide at the incorporating rolls.

(11) *Manufacture of Paints and Colours.*—Dust produced in grinding and mixing the dry lead colours.

(12) *Painting of Buildings, Coach Building and Miscellaneous Industries,* in which lead paints are used.—Dust produced by dry-sandpapering surfaces painted with a lead paint.

(13) *Shipbuilding.*—Dust produced by the chipping and scraping off of lead paint. Fume given off in inserting red hot rivets into holes containing yarn soaked in red lead and oil.

## Methods of Prevention.

(1) Substitution of non-lead for lead materials.

(2) Locally applied exhaust ventilation so as to remove dust and fume at the point of origin.

(3) The removal of lead paint by a wet process (waterproof sandpaper, wet pumice).

(4) Cleanliness of tools and workrooms ; damping of floors and material to prevent dust.

(5) Periodic medical examination of the persons employed in lead processes, and suspension of workers who have contracted or are in danger of contracting the disease.

(6) Personal Cleanliness.—Provision of suitable washing accommodation. Provision of special protective clothing and accommodation for outdoor clothes.

(7) Prohibition of food or drink in the workrooms. Provision of messrooms.

(8) Notification of all cases of lead poisoning to Central Authority.

## Signs and Symptoms of Lead Poisoning.

A blue line on the gums indicates the presence of lead in the system rather than lead poisoning.

*Anæmia.*—The first action of lead when absorbed into the system is on the blood and circulatory system, diminishing the number of red cells as well as altering their size and shape and reducing the amount of hæmoglobin. Changes in the blood are found in cases of both incipient and acute lead poisoning, characterised by alteration in shape and basophile staining of some of the red cells.

*Colic.*—The digestive symptoms often associated with plumbism include habitual constipation and attacks of colic.

*Arthralgia.*—The pain which may accompany any of the forms of lead poisoning does not usually follow the course of the nerve trunks, but is localised near the large joints, generally the knee, elbow or shoulder.

*Nervous System.*—Attacks of giddiness or persistent headache are significant in persons exposed to lead poisoning, and so too are tremor, numbness, or impairment of muscular action.

*Paralysis.*—The most frequent pronounced nervous symptom of lead poisoning is drop wrist due to paralysis of the extensors of the fingers and wrist.

*Interstitial Nephritis.*—Chronic kidney disease. This occurs in advanced cases of lead poisoning and is produced by the action of the lead on the smaller arteries of the kidney.

THE EXHIBIT consists of :—

(1) Photographs of processes and arrangements in the lead smelting, red and white lead, electric accumulator, indiarubber, pottery, printing and other industries, showing methods of preventing inhalation and absorption of lead dust and fumes.

(2) Wax models showing some of the signs of the disease (Case B).

(3) Two lead dross containers specially designed to prevent dissemination of lead dust :—

(*a*) A double chamber container. The dross falls through hinged cover of upper chamber, which closes automatically. The dross remains in upper chamber till cool. Base of upper chamber is also hinged and is opened by external levers when dross is cool, to allow it to fall into bag contained in lower chamber. When bag is full, upper chamber is lifted off, and bag is closed and tied and is then ready for removal to the smelters.

(*b*) Single chamber container. The dross falls through hinged cover which closes automatically. When container is full, hinged cover is lifted off and replaced by cover with locking attachment and the container is then ready for removal to the smelters.

*Lent by*—FRY'S METAL FOUNDRIES, Ltd., Christchurch Road, S.W.19.

## *IN ROOM NEXT TO LECTURE ROOM (BASEMENT).*

## Lead Paints.

Of all the industries in which lead is used in one form or another, the painting of buildings is the most productive of cases of lead poisoning. In 1929, 75 cases came to the knowledge of the Factory Department, of which 10 were fatal ; in 1930, 66 cases, of which 13 were fatal ; in 1931, 64 cases, of which 6 were fatal, and in 1932, 43 cases, of which 8 were fatal.

The chief source of danger in the industry is the fine dust produced in the processes known as rubbing down and scraping. Painted surfaces are in many cases rubbed down with sandpaper to produce smoothness and evenness of surface before the application of a fresh coat of paint. When this process is carried out dry, as it always was until quite recently, a fine dust is produced, and if lead paints are being used, this dust contains lead. Dust is also produced in the scraping of old painted surfaces before repainting.

A Home Office Committee which reported in February, 1923, recommended that with certain exceptions the use of lead paint for painting the interior of buildings should be prohibited, and that the use of lead paint for exterior work should be brought under Regulations.

About the same time a process of wet rubbing down with a new kind of sandpaper, known as waterproof sandpaper, was developed which, it

was claimed, would, if adopted, eliminate the dust risk from the rubbing down process. After much consideration it was decided by the Government that this new process should be given a trial before the use of lead paint for interior work was prohibited. An Act was accordingly passed in 1926 called The Lead Paint (Protection against Poisoning) Act, which gave power to the Secretary of State to make Regulations. The Government in passing this measure gave it to be clearly understood that if the Regulations to be made under it were not successful in combating the danger, the question of prohibition would again be considered.

Regulations have now been made under the Act and came into force on the 1st October, 1927. A copy of these in placard form, as required to be posted up by the employer, is shown.

These Regulations prohibit in general the dry rubbing down or scraping of surfaces painted with lead paint.

Samples of waterproof sandpaper are shown. The sandpaper is dipped in water before use. It can be cleaned after use in the same way, and can be used over and over again.

*Samples lent by—*
R. W. GREEFF & Co. Ltd., Thames House, Queen Street Place, E.C.4.
ASSOCIATED LEAD MANUFACTURERS Ltd., Brimsdown, Middlesex.

Where old painted surfaces are being treated, the employer must either satisfy himself that no lead paint has been used for the existing coats or he must use a wet method. To assist employers in ascertaining whether lead paint has been used or not, a simple and inexpensive test sufficient for the purpose has been worked out at the Government Laboratory. Particulars of this are contained in the leaflet shown. The apparatus for applying the test is also shown and means of demonstrating it are provided, viz.: 6 panels painted some with lead, some with leadless paints. The lower (and larger) part of each panel has received three coats; the portions above, two and one coat respectively. The test indicates the presence (or absence) of soluble lead, but does not determine its amount. If soluble lead is found, a wet method of rubbing down must be employed, unless a full chemical analysis, made in the method prescribed by an Order of the Secretary of State, shows the amount to be under the limit fixed by the Act.

Copies (*a*) of the Register which the employer is requried to keep of the persons employed by him in painting buildings and of the work on which they are so employed, and (*b*) of the leaflet containing special health instructions, which he is required to give to every person so employed, are shown.

*Painting of Vehicles.*—The use of lead paints in this industry is also subject to Home Office Regulations (1926). The same prohibition of rubbing down or scraping by a dry process applies.

*See* Statistics of Lead Poisoning, on Screens XII and XIV in Gallery.

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*IN GALLERY.*

## SILICOSIS.

Silicosis is by far the most serious of the group of lung diseases known as pneumonoconioses, which are due to the inhalation of dust. Silicosis is characterised by a special form of fibrosis of the lung tissue and follows the inhalation, usually over a prolonged period, of dust containing a considerable quantity of free silica. The dust of other minerals, notably certain silicates, also produces fibrosis of the lungs.

The disease occurs in occupations associated with the production of fine silica dust, of which the most important in this country are the grinding of metals on grindstones ; sand-blasting ; ganister mining and the manufacture of silica bricks ; certain processes in the manufacture of pottery ; quarrying and dressing sandstone and granite ; crushing materials containing quartz, chert or flint for various purposes, such as manufacture of steel, abrasive soaps and polishes, and pottery ; and the mining of certain ores.

Specimens of materials giving rise to silica dust are shown in Case F.

The silica, which may be in the form of quartz, flint or chert, gives rise to a very fine dust, and the particles which reach the lungs are nearly always under 1/5,000th of an inch in diameter ; the vast majority are less than a quarter of that size. They are invisible to the eye even when present in enormous numbers in the atmosphere.

The character and amount (i.e., number of particles) of the dust present in the atmosphere can be determined by means of delicate instruments such as Owens' Dust-counter, which is shown in Case W. Micro-photographs (600 magnification) and counts of the dust particles in a cubic centimetre of air taken in various processes are also shown in an album on the table adjacent. In practice, atmospheres are found containing over 2,000 particles in 1 cubic centimetre of air (approximately 33,000 in a cubic inch).

The effect of the inhalation of the dust on the lungs of the workers exposed to it is illustrated by micro-photographs of sections of lung (in the album referred to above), and by radiographs of lungs (arranged round the windows). *See fuller details below.*

The minute particles float in the air and are inhaled by the workers. When the particles enter the air passages along with the air current, many of them come into contact with the moist mucous membrane of the nose, throat, windpipe and bronchial tubes, and are easily expelled with the mucous secretion.

Other particles, of the smallest dimensions, are carried in the inspired air into the fine meshes of the lung tissue and then two things happen. Some, probably the majority of the particles, are breathed out again with the expired air, while others are deposited on the walls of the air cells of the lung. These can only be removed by the action of living, moving cells called phagocytes, which engulf the minute particles and carry them to the lymph channels and spaces which drain the lung (*see micro-photograph showing phagocytes* in album referred to above).

If the silica dust is excessive in amount the cells are unequal to their task and become stranded in the narrow channels and a blockage results. This process is going on all through the lungs at the same time and, if the inhalation of the dust is continued, the blockages form the centres of numerous nodules, the result of the irritation produced by the silica (*see micro-photographs showing nodules* in album referred to above).

These nodules increase in size and, in progressive cases, they tend to coalesce, producing extensive changes in the lung tissue with loss of function and consequent breathlessness.

Lungs in this condition are specially liable to attack by tuberculosis and it is largely owing to the development of this complication that the disease is so frequently fatal (*see illustrations showing tuberculosis* in album referred to above).

Once the fibroid nodules are established in the lungs they cannot be resolved. Progressive distortion of the lung tissue occurs in severe cases

and the symptoms tend to increase even after the patient leaves the occupation and ceases to inhale silica dust (*see radiographs of silicotic lungs*—arranged round the windows).

The chief means of preventing silicosis are those directed to the elimination of silica dust from the atmosphere of the work places. The principles to be adopted are (1) to prevent the production of dust by the use of wet methods, where practicable; (2) to remove dust by locally applied exhaust ventilation, as near as possible to the point of origin. The danger may also be minimised by segregating the processes associated with the production of silica dust so that no person is unnecessarily exposed.

Owing to the fineness of the dust, respirators have very limited protective powers and their use can never be regarded as a substitute for radical methods of dust suppression.

## X-Ray Photographs of Lungs of Workers in Pottery, Metal-Grinding and Refractories Industries.

A series of X-ray photographs of lungs of workers employed in the pottery, metal grinding and refractories industries is exhibited in the frames arranged round the windows. The photographs show the appearance of the lungs at different stages of silicosis and silicosis accompanied by tuberculosis. Albums containing prints from radiographs of cases of silicosis in several industries can also be seen in this section.

The diagnosis of silicosis presents great difficulty when reliance is placed solely upon ordinary clinical methods. The application of radiography has provided an aid of such remarkable value that it is recognised as the most important single factor in the differential diagnosis of silicosis from other respiratory diseases. Taken alone, the radiograph might be misleading, as can be seen by comparison with the radiographs of miliary tuberculosis and disseminated secondary tumours, which are shown in this exhibit. Taken in conjunction with the employment history and the clinical symptoms and signs, the radiograph renders the diagnosis of silicosis practically certain.

The changes produced in the lungs by the inhalation of silica dust are associated with the formation of fibrous tissue of such density that it can be recognised by X-ray photography. As an aid to the diagnosis of silicosis the form and distribution of the shadows produced by the fibrous tissue are of special importance.

The earliest radiographic evidence of silicosis is an increase in the breadth and density of the normal hilus shadows, and of the linear shadows which radiate from the hilus : at the same time the reticulate appearance of the pulmonary shadows, varying in character in normal subjects, becomes definitely coarser, and later, in typical cases, additional fine mottling appears, scattered diffusely and almost equally over both lungs.

Later stages show increasing density of the mottling, with coalescence to larger shadows as the area of the fibrotic nodules increases. The intervening spaces may be translucent owing to the presence of emphysema of the internodular lung tissue. In advanced cases much of the light area of pulmonary tissue is replaced by dense shadow, and complications are liable to be found.

Tuberculosis is the most frequent complication and it may appear at any stage of the silicotic process. It is to be recognised by more or less irregular shadows of varying size and position, usually more on one lung than the other, sometimes only on one lung. The tubercular process may spread rapidly and obscure the typical signs of silicosis, but it is usually possible to find a part of the lung free from tubercular lesions and retaining its typically mottled appearance.

## Silicosis in the Pottery Industry.

This Industry is illustrated by a series of photographs (Screens XIII and XVI) of the chief processes involving exposure to dust and the protective measures required ; by specimens of the materials used in the processes ; by micro-photographs and " dust counts " of the dust content of the atmosphere of the workrooms in which the processes are carried on ; by radiographs of the lungs of workers who have been exposed to the dust ; and by an exhibit (on the ground floor) of some of the plant used.

In the Pottery Industry silicosis arises chiefly from the inhalation of flint dust. Specimens of flint and other materials used in the manufacture of pottery are shown in Case F.

Flint, which is a form of crystalline silica, forms an ingredient in the body of some classes of ware ; and dust is produced in flint milling, making the slip, and forming and finishing the articles in the plastic state.

Powdered flint is also used for " placing " or embedding china for the first firing. Placing is the most dangerous of all the processes in exposing the workers to the inhalation of flint dust ; the subsequent removal of the adherent flint dust from the ware is also attended by considerable risk.

In 1933, 54 cases of silicosis or silicosis with tuberculosis were reported to the Department, of which 49 were fatal.

The Pottery (Silicosis) Regulations which came into force in 1932 deal especially with the dangers arising from the inhalation of dust in the industry. They require, amongst other provisions, efficient exhaust draught for the removal of dust in a variety of processes, enclosure of certain machines, impervious floors in potters' shops, and the cleansing of floors by a moist method or by vacuum cleaner.

## Silicosis in the Metal Grinding Industries.

These industries are illustrated by a series of photographs (Screen XVIII) of the chief processes and the protective measures required; by micro-photographs and " dust counts " of the dust content of the atmosphere in the rooms where grinding is done (see album) ; by radiographs of the lungs of workers who have been exposed to the dust ; and by specimens of the stones of which the grindstones are made (Case F).

In grinding metal on a grindstone, whether the work is done wet or dry, minute particles of quartz are liberated from the surface of the revolving grindstone and, unless adequate precautions are taken, are liable to be inhaled by the grinder. It is estimated that some 4,500 workmen are still employed on grindstones.

The amount of water used in the ordinary processes of wet grinding by hand is insufficient to prevent the escape of these fine particles of silica into the air. (See *micro-photographs and " dust counts "* in album).

Dry grinding on grindstones was formerly the most dangerous process in this industry, but the introduction and improvement of localised exhaust ventilation have made it less dangerous than wet grinding to which localised exhaust cannot be applied.

Besides the actual grinding, the grinder carries on certain incidental processes such as hacking and rodding, which liberate still greater quantities of dust from the grindstone. These processes are usually repeated several times during a working day.

Most dangerous of all processes is that of racing the new grindstones. Enormous quantities of fine dust are given off during this process.

Two Codes of Regulations under the Factory Act are in force—one dealing with the grinding of cutlery and edge tools and the other with the grinding of metal articles such as parts of machinery, stove grates, etc. The requirements of the Regulations are as follow :—

(1) A hood and duct with localised exhaust draught must be provided for all racing, dry grinding or glazing.

(2) Racing must be done in a separate room in cutlery and edge tool shops, excepting shops in use before January, 1926. In these shops it is allowed to be done when no other work is going on in the shop, provided the shop is cleaned before work is resumed.

(3) General exhaust and inlet ventilation must be provided adequate to secure a continuous movement of air from the grinder and to renew the air of the room twelve—in the case of cutlery and edge tool shops fifteen—times per hour.

(4) Wet grinding must be carried on in a separate room from glazing or other process.

(5) An adequate supply of water is required for hacking and rodding or alternatively adequate provision for intercepting the dust.

(6) The rooms must be of a minimum height, windows must be adequate, properly glazed and kept clean.

(7) Floors and walls must be so constructed as to be capable of being cleaned and all belts, shafts, etc., efficiently covered.

(8) There must be adequate drainage for water.

(9) All floors, walls, ceilings and fixtures must be cleaned periodically.

(10) Spitting is prohibited.

(11) Cloakroom accommodation must be provided.

(12) Grindstones must not be less than the prescribed distance apart.

*Reference* :—

" Report on Grinding of Metals, with special reference to the effects of dust inhalation upon the worker " ; by E. L. Macklin, O.B.E., and E. L. Middleton, M.D., D.P.H., 1923 ; published by H.M. Stationery Office.

## Silicosis in the Refractories Industries.

This group of industries is illustrated by a series of photographs (Screen XIX) of the chief processes and the protective measures required ; by specimens of the materials used in the processes ; and by radiographs of the lungs of workmen who have been employed in the industry.

It includes the quarrying and mining of highly siliceous " refractory " material and its subsequent manipulation and treatment in the manufacture of silica and ganister bricks, and certain cements and moulding compositions chiefly used in the manufacture of steel and articles of steel. It employs some 3,000 workmen.

Materials include silica rock, ganister, certain highly siliceous sands, flint and chert. Specimens of these will be found in Case F.

Dust is liable to be produced in all processes of breaking, crushing, or grinding the material, unless it is in a very moist condition. Dust is also produced when the raw material is calcined, and also when the moulded bricks are dried, and set in and drawn from kilns.

The chief preventive measures which have been laid down by Home Office Regulations under the Factory Act are the following :—

(1) Breaking of refractory material by hand must be done in the open air.

(2) Crushing and grinding of material in a machine must be done only with efficient exhaust draught, or with an efficient water or steam spray, unless the material can be manipulated in a sufficiently wet state to prevent the escape of dust.

(3) All elevators, screens, sieves, etc., must be entirely enclosed and be provided with exhaust draught so arranged as to prevent escape of dust.

(4) For loading and unloading, the material must be so damped as to preclude dust, or placed in a suitable dust proof container. In shovelling or raking, or otherwise manipulating by means of hand tools, the material must be so damped as to prevent dust or be under an efficient exhaust draught.

(5) Silica brick drying floors must be cleaned by a moist method.

(6) The use of drying stoves is prohibited.

(7) All floors or other places where persons are liable to pass must be effectively damped and cleaned at least once every day. The débris must be damped and placed in covered receptacles.

(8) Brick plates must be effectively damped before cleaning.

(9) Refractory material must not be used for dusting brick moulds.

Periodic medical examination of the workmen in these industries has also been made compulsory since February, 1919, under the Scheme issued by the Home Office in pursuance of the Workmen's Compensation (Silicosis) Acts for the compensation of workmen in these industries who are disabled by silicosis. Any workman found to be suffering from silicosis or tuberculosis or both to such a degree as to make it dangerous for him to continue work in the industries, must be suspended from further employment in the industries. Workmen are also examined on entering the industries and any who fail to reach the prescribed standard of physique are excluded.

## PHOTOGRAPHS.

### Silicosis in other Industries.

Preventive measures employed in other industries where there is danger of silicosis are shown in the adjacent revolving screen.

(*See also Stone-dressing exhibit in yard outside—page* 191).

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## ASBESTOSIS.

Asbestosis is a disease of the lungs caused by the inhalation of asbestos dust, usually over a period of years. The ease with which asbestos can be broken longitudinally into extremely small particles in part explains some of the features of the disease it produces. The long and narrow particles in the dust inhaled are caught in the finest air passages of the lung; and the disease may be visualised as a slow growth of fibrous tissue in the form of a network wherever the inhaled dust comes to rest. As a result, large areas of the lungs may cease to function, and the remaining undamaged tissue may become insufficient to cope with the demands made on it should some acute infection, such as bronchitis, pneumonia, or influenza, supervene.

As with silicosis the diagnosis of asbestosis depends on careful consideration of the clinical signs and symptoms, the employment history, and the radiographic picture. The radiographic appearances of developed asbestosis are distinctive: a typical feature being the "ground glass" appearance as contrasted with the "snow storm" type (a much coarser mottling) seen in many cases of silicosis.

The exhibit contains a number of radiograms of cases of asbestosis which may be conveniently compared with the adjacent silicosis plates.

Specimens of crude and manufactured asbestos in the preparation of which asbestos dust is liberated are shown in case F2.

## Prevention.

Although the range of asbestos products is very large only a comparatively small number of workers are liable to be exposed to risk from the dust. These are to be found mainly amongst those engaged in crushing or otherwise preparing the crude mineral in the manufacture of asbestos textiles, and in the making of mattresses and other insulating materials. Owing to the lightness and fragility of asbestos fibre any handling of it produces dust, often in dangerous concentration.

A strict code of preventive measures, the Asbestos Industry Regulations, 1931, is in force, directed to minimising the production of, and exposure to, dust by a variety of means. These include, among others, efficient localised exhaust ventilation, enclosure of machines, separation of processes and the use of breathing apparatus of approved type by persons employed in certain specially dangerous operations. Examples of suitable apparatus are to be found in the Ventilation, Respirator, and Breathing Apparatus Exhibits.

*References :—*

Merewether, E. R. A., and Price, C. W. Report on the Effects of Asbestos Dust on the Lungs and Dust Suppression in the Asbestos Industry. London : H.M. Stationery Office, 1930.

Report on Conference between Employers and Inspectors concerning Methods for Suppressing Dust in Asbestos Textile Factories. London : H.M. Stationery Office, 1931.

Memorandum on the Industrial Diseases of Silicosis and Asbestosis. London : H.M. Stationery Office, 1932.

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# DERMATITIS.

Cases of dermatitis among workers, arising from contact with skin irritants, occur in a great variety of industries. It has been claimed that more days' work are lost from dermatitis than from any other complaint. The number of cases in which workers are certified under the Workmen's Compensation Act as disabled by dermatitis or ulceration of the skin

caused by dust or liquids, has risen steadily and in 1932 was over 2,200. Many substances may cause dermatitis. It will be seen that the baking of bread and the manufacture of flour confectionery are responsible for a very large number of cases. The dough and sugar used in these industries, and alkalies, dyes, oil, turpentine and its substitutes, and French polish, are responsible for most of the cases.

Prevention lies in the preservation of the horny outer layer of the skin by (1) removal of irritant substances as soon and as thoroughly as possible —this calls for strict cleanliness ; (2) protection by gloves and sleeves where this is possible ; and (3) First Aid treatment of injuries.

The exhibit (Screens XX and XXI, and Cases G and H) consists of :—

(*a*) Photographs of dermatitis and other skin diseases.

(*b*) Photographs illustrating preventive measures adopted in various industries (washing facilities, first aid treatment for injuries, and examination of hands and arms when selecting workers and also as a routine measure during employment).

(*c*) Wax models of hands showing (1) dermatitis, (2) arsenic keratosis, (3) alkaline burn ; and an instance of oil " acne " of the forearm.

(*d*) Different types of gloves, gauntlets and sleeves to protect the hands and arms from different irritants. These should be (1) of adequate size and material, (2) intact, and (3) dry, and should be powdered before and after use.

(*e*) Chart showing incidence of dermatitis in industrial occupations (as indicated by cases of disablement, lasting more than three days, certified under the Workmen's Compensation Act) over a period of years.

# OTHER INDUSTRIAL DISEASES.

## Epitheliomatous Ulceration. (Skin Cancer).

Wax models of the hands and arms of a number of workers in paraffin and pitch are shown in Case C. The effect (i.e., pigmentation, formation of papules and warts) of these irritants after varying periods of exposure is illustrated, with the gradual progression of the condition into that of ulceration. Prevention lies in cleanliness, periodic medical examination and immediate treatment of warts.

For chart showing numbers of reported cases, *see* Screen XIV.

## Chrome Ulceration.

Is produced by the action of chromic acid and potassium or sodium bichromate (either as crystals or in solution) on the skin and mucous membranes, and occurs chiefly in the manufacture of chromic acid, or bichromate of potassium or sodium, and their use in chromium plating, dyeing, French polishing and other industries. Dermatitis occurs, but the more frequent lesion is what is familiarly known as a chrome " hole," i.e., ulceration. *See* Screen XX and model in Case B.

Prevention lies in the protection of the exposed parts of the arms and hands, e.g. by wearing gauntlets of suitable length and material; in some industries protection for the feet and legs is required. *See* Case H and section on Protective Clothing.

Regular inspection at short intervals of the hands and arms of workers, strict cleanliness and prompt First Aid treatment of all injuries, will do much to prevent the occurrence of chrome dermatitis and ulceration.

Home Office Regulations for Chromium Plating also require periodic medical examination of persons employed and exhaust ventilation for plating baths and polishing machines.

## Chronic Benzol Poisoning.

A cast is shown in Case B. The poisoning is caused by the inhalation of benzol vapour, and chiefly occurs in the manufacture of articles of indiarubber, chemical works, and dye works. The most important sign of poisoning is a form of anæmia, with hæmorrhages into the skin and from mucous membranes (mouth, nose, stomach, etc.).

Prevention lies in localised exhaust ventilation, efficient general ventilation, and in periodic medical examination.

*To face p. 149.*


WELFARE SECTION.

Work seats suitable for various processes.

## Anilin Poisoning.

A cast is shown in Case B. The poisoning is caused by the absorption through the skin of anilin, dinitro benzol, or similar bodies or by inhalation of their vapours or dust, and occurs chiefly in chemical works ; manufacture of dyestuff intermediates ; anilin black dyeing. The first signs of poisoning are headache and cyanosis. Prevention lies in the enclosure of vessels, avoidance of splashing, protective clothing, exhaust ventilation and periodic medical examination.

## Mercury Poisoning.

A wax model is shown in Case B. The poisoning is caused by the inhalation of vapour and possibly by ingestion of minute globules of mercury, and occurs chiefly in the manufacture of thermometers ; manufacture and repair of electric meters ; manufacture of scientific instruments. The signs of poisoning are salivation, inflammation of the gums, tremor of the hands. Prevention lies in the provision of exhaust ventilation, protective clothing, cleanliness of floors, benches and workers' hands.

Photographs of protective arrangements adopted at the Birmingham Corporation Electric Meter Repair Works are shown on Screen XI.

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# SEATS FOR WORKERS.

This exhibit is designed to illustrate two matters which researches into fatigue and efficiency have shown to be of importance, but which in many cases receive little or no attention from the management.

One is the provision of seats for occasional rest where work has to be done standing.

The other is the suitability of the seat for the accomplishment of the work to be done, where the work has to be done sitting.

*Prevention of Fatigue.*—Less fatigue is caused to workers when work can be done sitting, but in many industries this is not possible and the fatigue caused by prolonged standing may be lessened by occasional rest. In most processes pauses occur in the course of work of which advantage can be taken by the worker if facilities for sitting are provided. While the provision of such facilities is advantageous in the case of all classes of workers, it is of special importance where women or girls are employed. In their case prolonged standing may be the cause of excessive fatigue, and in the Welfare Orders made by the Home Office under the Factory Acts for certain trades the occupier is required to provide all female workers whose work is done standing with facilities for sitting. These Orders at present cover only a small part of industry, but provision of seats for occasional rest should be possible in most, if not *all*, industries.

Difficulties in the way of finding room for seats in workrooms crowded with machinery or materials can be met by providing seats which, when not in use, can be tipped up or swung out of the way.

Again, there are many kinds of work which can be done equally well sitting or standing. It has been found to have excellent effects if arrangements are made to enable workers to change from one working position to the other during spells of work. The change of posture gives relief to the worker, diminishes fatigue and the liability to mistakes, and increases efficiency and output.

*Suitability of Design of Work Seat.*—When work is done sitting, it is obviously desirable that the seat should be of a kind to enable the worker to work as comfortably and rapidly, and with as little fatigue, as possible. Many work seats that are found in use in factories seems to fulfil none of these requirements. To give the worker the healthy and uncramped position which is necessary, both the design of the seat and its adjustment to the work-bench must be considered. As workers are of different heights the seat provided should be either chosen to suit the height of the worker or should be capable of adjustment. Similarly, a back rest, if provided, should also be adjustable vertically. A foot-rest should be provided in all cases where the position of the worker is such that the feet do not rest easily on the ground ; this can be provided on the work-bench or work-table. The shape of the seat should be more or less square, of ample breadth and should not have a sharp edge. Where a worker is seated before a dangerous machine, the seat should be fastened to the floor.

*Reference* :—

Home Office Welfare Pamphlet No. 6, " Seats for Workers in Factories and Workshops," published by H.M. Stationery Office.

THE EXHIBIT includes the following :—

## Seats for use during short pauses from work.

Bench, with back rest, allowing workers to relax in short intervals between spells of work. Suitable for use where there is a sufficient free space in workroom.

*Used in Departments where biscuit travelling ovens are operated in Works of*—
MACFARLANE LANG & Co., Ltd., Syon Hill, Isleworth.

Stool, which can be attached to work benches, pillars in a room etc., and when not in use can be swung aside out of the way.

*Used by attendants at travelling bands in Packing Departments in Works of*—
MACFARLANE LANG & Co., Ltd., Syon Hill, Isleworth.

Stool, which can be fixed to the floor near the work bench and when not in use can be closed up so as not to occupy valuable space.

*Supplied by*—JAMES GIBBON, Ltd., Wolverhampton.

Low comfortable chair fixed to wall and folding up readily to take little space when not in use. Rows of these can be fixed back to back on a stand.

*Used at*—Tapestry Works of A. H. LEE & SONS, Ltd., Birkenhead.

Stool, which, when not in use, tips up and occupies very little space.

*Supplied by*—SANKEY SHELDON, London.

Chairs, designed for stacking in small space when not in use.

*Supplied by*—RONEO, Ltd., London.

## Seats for use while working.

Seats of which back rest swivels and adjusts itself to sitter's back. Seat shaped or rounded off for comfort.

*Supplied by*—THE TAN-SAD CHAIR Co., Ltd., London.

Revolving type of chair provided with adjustable swivelling seat and back rest.

*Supplied by*—THE TAN-SAD CHAIR Co., Ltd., London.

Chair with the seat constructed of metal springs. Back rest is adjustable in two ways and also swivels to suit sitter's back. Foot rest adjustable vertically and horizontally.

*Used in the Chocolate Dipping Department of*—J. LYONS & Co., Ltd., Greenford.

Seat, revolving and adjustable in height to suit need of individual worker. The spring back is adjustable.

*Used at some of the machines in the Cardbox Making Department of*—
CADBURY BROS., Ltd., Bournville.

Seat for use when a very high seat is necessary. The back rest, the foot rest and the seat are made adjustable so as to ensure correct posture and the seat is shaped for comfort.

*Used at a conveyor in Works of*—ROWNTREE & Co., Ltd., York.

A high chair provided with wire cage in which the worker keeps scrubbing brush and cleaning materials necessary for cleaning her bench.

*Used in the Chocolate Dipping and Packing Departments of*—
CADBURY BROS., Ltd., Bournville.

A high chair provided with back rest and foot rail. The edge of the seat is rounded. The chair is light and can easily be moved. The white wood shows dirt quickly and can be thoroughly cleaned without difficulty.

*Used by finishers in the Fruit Preserving Works of*—
THE CO-OPERATIVE WHOLESALE SOCIETY, Ltd., Acton.

A high chair provided with back rest and foot rail.

*Used in the Soap Works of*—
THE CO-OPERATIVE WHOLESALE SOCIETY, Ltd., Irlam.

Stool for use where low seat is necessary—stands very firm, so minimising risk of an accident due to a fall.

*Used by workers at Wafer Stoves and other machines in Works of*—
MACFARLANE LANG & Co., Ltd., Syon Hill, Isleworth.

Stool used in conjunction with a foot rest of suitable height under the work bench. The rocking seat throws the body forward, increasing foot comfort and convenience for working.

*Used in a Chocolate Packing Department of*—J. LYONS & Co., Ltd., Greenford.

Stool, with the seat shaped for comfort.

*Used in a Chocolate Packing Department of*—J. LYONS & Co., Ltd., Greenford.

Stool provided with foot rest and box for waste.

*Used by the beamer attendants in a Cotton Mill of*—
THE FINE COTTON SPINNERS & DOUBLERS ASSOCIATION, Manchester.

Stool, with large and comfortable seat and a covering that can easily be renewed ; light in weight, it can be moved readily.

*Used in Boot-making Works of*—C. & J. CLARK, Ltd., Street, Somerset.

Stools of which height is adjustable, with seats shaped for comfort. One is provided with back rest. Simple in design and easily moved.

*Supplied by*—JAMES GIBBON, Ltd., Wolverhampton.

Seat for working at embroidery frames. The height of the chair and of the platform on which it stands and also the distance of the foot rest from the chair are made to suit the particular worker. The back supports are slightly springy and are shaped to the body so that the worker's elbows do not strike against them. Seat cut away at front to avoid sharp edge. Box below is for waste material and can be cleared while the seat is in use.

*Used at Tapestry Works of*—A. H. LEE & SONS, Ltd., Birkenhead.

A form of light collapsible stool, particularly convenient where workers are temporarily employed.

*Used by*—PEEK FREAN & Co., Bermondsey, S.E.

Small collapsible stool used in the Drawing and Cardrooms of a cotton mill where space is restricted. It can be easily folded up and put away, and is provided with a safety hinge to prevent collapse while in use.

*Used at Cotton Mill of*—CALEB WRIGHT & Co., Ltd., Tyldesley.

Wooden seat on wheels used for doffing at the lowest spindles. (See photographs in Labour Saving Section).

*Used in Works of*—COURTAULDS, Ltd., Braintree.

Sliding seat suitable for use where, in the course of the work, the worker has to move along the work table or bench, e.g., in examining a length of cloth.

*Used at Tapestry Works of*—ARTHUR H. LEE & SONS, Ltd., Birkenhead.

An old stool converted into a high chair by addition of a back rest which can be made 12, 13 or 14 inches high.

*Used in Works of*—J. B. LEWIS & Co., Nottingham.

Seat for use while working, fitted with an adjustable back. The slides provided enable the seat to be moved backwards or forwards.

*Lent by*—BRITISH XYLONITE Co., Ltd., Hale End.

Swivelling seat, adjustable in height from 18 inches to 22 inches. The legs are fitted with ball castors. The back rest is also adjustable.

*Lent by*—SAXELBYS, Ltd., Coventry.

Seat with adjustable back rest. The seat, of wood, is shaped for comfort.

*Lent by*—SAXELBYS, Ltd., Coventry.

Strong chair on casters. Back rest and seat are shaped for comfort.
*Lent by*—J. B. BROOKS & Co., Ltd., Birmingham.

Seat swivelling, with a collapsible back rest. Can be pushed under bench when not in use. Seat is adjustable in height and a stop is provided to prevent the seat swivelling away from the operator.
*Lent by*—WILLCOX & GIBBS SEWING MACHINE Co., Ltd., 20, Fore Street, E.C.2.

Seat provided with adjustable spring back rest.
*Lent by*—OXO, Ltd., London.

A cheap and strong form of seat, very suitable for seasonal industries.
*Lent by*—ALLIED PRODUCTS & SLOTTED STEEL Co., 176, Victoria Road, Aston, Birmingham.

Swivel seat—height can be easily adjusted ; back rest is also adjustable vertically and horizontally.
*Lent by*—THE LEABANK MANUFACTURING Co., Ltd., Hoddesdon.

" Coneseat " stool for use whilst working. The height of the stool is adjustable. The seat swivels and a footrest is provided. The top is covered with sponge rubber for comfort.
*Lent by*—RICHFORD & Co., Ltd., Milner Works, Barnsbury Street, N.1.

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## PHOTOGRAPHS.

### (Screen XXII)

Experiments carried out by the National Institute of Industrial Psychology at the works of the British Xylonite Co. Good and bad arrangements in regard to design of seats, arrangement of work, etc.

Seats for spinners, warpers, and beamers in cotton mills ; for chocolate dippers ; for biscuit decorators ; for packers and solderers in biscuit works ; for sewing machinists ; for decorators and biscuit-ware brushers in potteries ; and for biscuit tin washers.

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# WELFARE SUPERVISION.

Welfare supervision is an important part of the welfare arrangements in a factory, but one which cannot easily be illustrated because of its personal character. The Welfare Supervisor's room, which forms part of the Welfare Exhibit, therefore, is shown more by way of suggestion and to indicate the relation of the Welfare Supervisor to the other parts of the welfare arrangements in a factory, than of illustrating particular points or giving any exact representation of the Welfare Supervisor's place in factory organisation.

Welfare supervision—though it made its appearance in this country before the war—received its first great impulse from the conditions under which industry had to be carried on during the war ; and the recognition of its importance has increased, despite adverse conditions of trade, with the increasing sense of the importance of the human factor in industry.

The number of Welfare Supervisors now employed in the factories of the country is about 1,000 men and women.

The appointment of a Welfare Supervisor in a works being, in general, a voluntary matter on the part of the employer, the position in the factory of the Supervisor and the scope of his or her duties may vary considerably, according to the size and organisation of the factory, nature of the work carried on, views of the employer, and the like.

It is generally essential to the success of the Supervisor's work that he or she should be given a position of sufficient authority and should be responsible directly to the management, and to no one else.

The duties of the Supervisor will include at least the general supervision over the various welfare arrangements in the factory to ensure their being kept thoroughly efficient, and the study of various matters affecting the health, comfort and efficiency of the workers (the elimination of unnecessary or undue fatigue, involving examination of such matters as provision of rest-pauses, posture of workers at their work, labour-saving appliances, etc., etc., may be instanced). In many cases it is found to be advantageous that the selection of new workers should be in the hands of a Supervisor with experience and training to find the right sort of man or woman, boy or girl, for the job and prevent the engagement of the wrong sort. By this means the labour " turn over " at a factory, with its loss of time and efficiency, may be greatly reduced.

THE EXHIBIT includes :—

Suitable furniture, consisting of writing table, chairs, book-case, etc.

Specimens of works' magazines, information with regard to welfare schemes, works committees, etc., and record cards obtained from various works (in cupboard).

Card index case with lock, containing specimen record cards as to health, etc., of individual workers.

*Lent by*—RONEO, Ltd., 5-11, Holborn, W.C.1.

Notice board for exhibition of notices relating to welfare arrangements.

Labour turnover chart.

Abstract of Factory Acts.

Suggestion scheme record in a works.

*Reference* :—

" Welfare and Welfare Supervision in Factories and Workshops " (Home Office, 1931), published by H.M. Stationery Office.

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## CANTEENS AND MESSROOMS.

With growing decentralisation of industry, the difficulties caused by the housing problem, the increasing facilities for travelling, and other changes in the conditions of life, more and more of the workers tend to come from a distance to their work, and are unable to get home for at least one of the important meals of the day.

Where this happens and (as is often the case) adequate provision is not available outside and near to the factory, the question of providing accommodation for getting or taking meals in the works itself becomes an important one which concerns the interests of the employer as well as those of the worker.

As was found during the war, when the conditions necessary to secure the highest possible production of war material had to be carefully

*To face p. 156.*

WELFARE SECTION.

Canteen exhibit: service hatch on right; bill of fare on wall.

studied, the meal arrangements are an important factor in securing the most efficient work. Efficiency is impossible without health, and bad arrangements for food can only lead to a lower standard of health.

Arrangements in a factory may take the form of a canteen where meals are provided, or a messroom where the workers take the food they have brought with them. Important points about a canteen or messroom are :—

(1) The equipment for { preparing / warming } food.
(2) Quick and orderly service.
(3) Comfortable arrangements (tables, chairs, etc.).

These are illustrated in the Exhibit which includes :—

A model of a canteen (necessarily on a small scale).
Photographs and plans of actual works canteens or messrooms.
Equipment.

Owing to the impossibility of reproducing completely all the arrangements of a fully equipped canteen or messroom, the exhibit is limited to illustrating certain points which are indicated in the descriptive notices.

Complaint is sometimes made by those who have established canteens or messrooms that the workers will not use them. It may be that in such cases the habits, likings, prejudices, and so on of the workers have not been studied. For instance, many workers who bring their own food like to take it by themselves or in the company only of one or two friends. If they cannot do this in the canteen or messroom, they will go elsewhere. The provision of some *small tables* may get over the difficulty.

Workers who bring their own food (whether because they are not able to afford even canteen prices, or for other reasons) should be given facilities for warming their food, and unless a separate messroom is provided for them, they should be made to feel as much at home in the canteen as those who get their meals from the canteen.

Cheerfulness in the aspect of a canteen is essential to success (a dingy canteen will never attract the workers if they can find some place more to their liking in which to take their meals), and helps greatly to make the meal hours—as the interests of the employer as well as of the worker require that they should be—intervals in which the mind and spirits of the worker as well as the body are rested and refreshed. Flowers on the tables and bright prints on the walls are some of the means by which a canteen may be made to look attractive and are to be found in many successful canteens. Really good artificial flowers may be used for the purpose and indeed have some advantages over natural flowers. Artificial flowers supplied by Messrs. Marshall and Snelgrove, Oxford Street, London, and colour prints of flowers are shown.

Many canteens are run at a loss, the firm being content to make good the deficit. It is possible, nevertheless, to provide cheap meals and yet cover expenses, and some works, small as well as large, succeed in doing so.

The efficiency of the worker is increased by allowing in the course of a long spell of work, a few minutes pause for rest and refreshment. This has been conclusively shown alike by the experience of firms which have tried it and by the scientific investigations of the Industrial Fatigue Research Board. Many firms find it better to send round in the workroom a trolley bringing tea and other refreshment rather than let the workers scatter to get what they want. A specimen of a trolley suitable for the purpose is shown.

*References* :—

" Messrooms and Canteens at Small Factories and Workshops " ; " Scheme of Factory Canteen for 250 Workers " ; published by H.M. Stationery Office.

THE EXHIBIT includes the following :—

*Service barrier,* aids quick service by regulating queue traffic at the service counter—customers enter at one end and leave at the other.

*Service hatch and counter* between kitchen and canteen is shown closed. At the meal times this panel would be raised and food served over the counter direct from the kitchen to the customers in line inside the barrier. A long counter may conveniently be divided into several sections for different kinds of food. The counter should be of hardwood, easily kept clean, and should be wide enough to take easily large-size dinner plates.

*Table,* 4 ft. by 2 ft. Seats four to six persons. Hardwood, covered with 3 in. square white tiles with $1\frac{1}{2}$ in. hardwood beading : is easily kept clean, and is attractive in appearance.

*Lent by*—J. FARQUHARSON & SONS, 59–64, Houndsditch, E.C.3.

*Tea service, green teapot, jug, bowl and flower vase,* made of strong ware, with leadless glaze.

*Lent by*—LEADLESS GLAZE CHINA Co., 16, Belgrave Road, S.W.1.

*Chairs* of varnished hardwood—strong and easily kept clean.

*Lent by*—J. FARQUHARSON & SONS, 59–64, Houndsditch, E.C.3.

*Table,* 2 ft. 6 in. by 2 ft. 6 in. Seats four persons. Hardwood covered with linoleum, with $1\frac{1}{2}$ in. hardwood beading, flush with the edge of the linoleum ; easily kept clean and will stand hard wear. This table is shown laid out for those who bring their own food instead of buying the canteen dinner, with wastepaper baskets for wrappings.

*Lent by*—J. FARQUHARSON & SONS, 59–64, Houndsditch, E.C.3.

VIEW IN GALLERY.

In front, canteen kitchen equipment and refreshment trolley.

*To face p. 158.*

*Chairs* of varnished hardwood with seat of comfortable shape.

*Lent by*—T. GLENISTER, Ltd., High Wycombe.

*Plates,* with rolled edges ("hotel type"), which are less easily chipped than the ordinary straight edge.

The small ones are made with leadless glaze.

*Lent by*—THE LEADLESS GLAZE CHINA Co., 16, Belgrave Road, S.W.1.

The large ones are made with low solubility glaze.

*Lent by*—J. FARQUHARSON & SONS, 59–64, Houndsditch, E.C.3.

*Table,* 5 ft. 6 in. by 2 ft. 3 in., seats six to eight persons. Design suitable for use in canteens which are also used for recreation rooms. Table is collapsible and can be taken down quickly by moving the two hooks below, yet strong enough with others to make a platform.

*A coloured cloth*—brightens a room and does not show soiling as quickly as a white one.

*Table lent by*—MIDLAND EDUCATION Co., Ltd., Birmingham.

*Water jugs,* Devon ware, salt glaze, keeps liquids cool.

*Pepper, salt and mustard,* green ware, leadless glaze, stand heavy use, and are easily kept clean.

*Flower vase.*—Similar ware.

*Lent by*—THE LEADLESS GLAZE CHINA Co., 16, Belgrave Road, S.W.1.

*Material for curtains in canteen supplied by the makers*—THE ETON RURAL FABRICS (SANDERSON & SONS, Ltd.), Hundred Acres, Uxbridge.

*Knives* of stainless steel all in one piece, easily kept clean and unbreakable.

*Spoons and forks* of Sutherland silver require little cleaning and keep their colour well.

*Bench, with back rest.*—Suitable for canteen where chairs are not practicable.

*Lent by*—J. FARQUHARSON & SONS, 59–64, Houndsditch, E.C.3.

*Folding chairs* of varnished hardwood, for use in canteens which also serve for recreation and social rooms. Easily taken down and put up again. Can be stacked in small space.

*Cup rack,* into which dirty cups and saucers can be stacked at tables and easily carried to the washing-up sink.

*Lent by*—STAINES KITCHEN EQUIPMENT Co., Ltd., 94, Victoria Street, S.W.1.

*Rack* for carrying 20 pint pots or mugs to washing machine from tables. The pots remain on the rack during the processes of washing and drying.

*Supplied by*—TURNER BROS. ASBESTOS Co., Ltd., Rochdale.

*Water boiler.*—Constant supply of boiling water for tea making, etc., for large numbers. This size gives 240 pints of boiling water per hour and is gas-heated. Water is supplied direct from the main and can only be drawn off when boiling. One handle controls gas and water supplies. Note drip tray to aid cleanliness.

*Lent by*—J. STOTT & Co. (ENGINEERS), Ltd., Queen Victoria Street, E.C.4.

*Water boiler.*—Constant supply of boiling water for tea making, etc. The boiler is gas heated and water is supplied direct from the main to the tank and is controlled by a ball valve. The water can only be drawn off when boiling. One handle controls both gas and water supplies.

*Lent by*—JACKSON BOILERS, Ltd., Leeds & London.

*Canteen trolley* for serving tea, lemonade, soup, etc., quickly in the actual workrooms during short rest or refreshment pauses. Can also be used in canteen for quick clearance of tables after dinner.

The following features may be noticed. They are applicable to other sizes and designs :—(1) Hardwood is easily kept clean and stands rough usage ; (2) wheels are suitable for running easily over uneven factory floors ; (3) drop fronts to the trays enable them to be easily filled and emptied and easily cleaned. Zinc lining is easily wiped if tea, etc., be spilt.

*Lent by*—J. FARQUHARSON & SONS, 59–64, Houndsditch, E.C.3.

*" Staybrite " steel urn* for serving hot or cold drinks quickly to numbers, e.g., in workrooms during rest pauses. The *Auto-tap nozzle* saves repeated turning on and off of tap. Tap is kept full on and flow is regulated by the cross bar ; the bar is pressed up by the rim of the cup, which allows the liquid to run ; as soon as cup is lowered, the bar drops and the flow automatically stops.

*Lent by*—SUMERLING & Co., Ltd., Old Street, E.C.1.

*Rockingham teapot.*—Capacity 8 pints, for counter or trolley service of tea, etc., often preferred to urns where numbers are not too large.

*Lent by*—J. FARQUHARSON & SONS, 59–64, Houndsditch, E.C.3.

*Steam oven.*—Such ovens are used to steam large quantities of potatoes, puddings and fish. Separate steam control for each compartment. The wastes would be connected to a condense box or grease trap, fitted with automatic valves, completely isolating each compartment. The doors fit against grease packing to prevent the escape of steam, and are fastened by wheel and screw fastenings which safeguard against sudden escape of steam. The capacity of each of the perforated galvanised trays shown, is 18 lbs. of potatoes or 20 individual pudding moulds.

*Lent by*—BENHAM & Co., Ltd., Wigmore Street, W.

Note inside ; (1) aluminium pudding moulds (individual) to ensure uniformity in size of portions ; (2) aluminium tins for steamed puddings ; (3) leadless glaze pudding bowls.

*Steam-heated tip boiling copper,* for boiling large quantities of soup or green vegetables. This copper holds 20 gals. The weighted lid is steam-tight, preventing any escape into the room and is easily raised and lowered. The pan tilts easily by turning the handle.

*Lent by*—J. SLATER & Co. (ENGINEERS), Ltd., London.

*Drinking water fountains* of the jet type, render drinking vessels unnecessary.

*Lent by*—T. A. HARRIS, Ltd., 56, Blackfriars Road, S.E.1.
WILLIAMSON & Co., 13, Coupar Street, Dundee.

*Hot closet,* gas-heated (hot closets may also be heated by steam or electricity). Facilitates quick service at the dinner-hour rush. Portions can be prepared beforehand, stacked in tiers inside the closet, and kept hot so that the kitchen staff have a good start before rush begins. This size holds 100 stacked meals. It is raised on feet to enable floor underneath to be cleaned easily.

*Lent by*—BENHAM & SONS, Ltd., 64–66, Wigmore Street, W.

Note method of stacking plates inside by use of metal rings.

*Aluminium rings.*—By using these rings portions can be got ready beforehand and stacked in hot closets to keep warm—method shown inside hot closet exhibit.

*Lent by*—STAINES KITCHEN EQUIPMENT Co., Ltd., 94, Victoria Street, S.W.1.

*Net for deposit of aluminium rings,* when taken from the plates as they are lifted from the oven.

*Lent by*—MORLAND & IMPEY, Ltd., Kalamazoo Works, Northfield, Birmingham.

*Wooden stand for deposit of aluminium rings,* when taken from the plates as they are lifted from the oven.

*Lent by*—J. B. LEWIS & SONS, Nottingham.

*"Hotlock,"* a device for keeping cooked food hot for a long period without drying it up or otherwise affecting its freshness. It consists of a metal chamber with an inner and an outer wall and, underneath, a small grate in which compressed carbon ("Dally fuel") is burned. The heat circulates between the two walls of the chamber and a small block of the fuel lasts for several hours. The device is useful in cases where

there is an interval between the cooking and consumption of food, e.g., when the food has to be kept warm for a night-shift or has to be transported for some distance.

*Lent by*—HOTLOCK, LTD., 12, Buchanan Buildings, E.C.1.

*Teak sink for canteens.*—Teak being a very hard wood is very little affected by continual wetting and it is claimed that there is less breakage of crockery with a wooden than with a stone sink. The trumpet waste forms a safe outlet for the water, in case taps should be inadvertently left running, and there are strainers across the corners where the waste outlet is situated to prevent refuse escaping into the waste and stopping up drain pipes. Grooving on draining board facilitates draining.

*Supplied by*—JAMES FARQUHARSON & SONS, 59–64, Houndsditch, E.C.3.

*Vegetable paring machine* (electrically driven) saves labour in preparing potatoes and other vegetables. This size deals with 14 lbs. of potatoes in one minute.

*Lent by*—THE IMPERIAL MACHINE Co., Victoria Works, Edgware Road, N.W.2.

*Gas-heated fish fryer* for frying large quantities of fish and potatoes. It should have canopy and exhaust pipe—as shown—to outside air to remove fumes and smell.

*Lent by*—THE FALKIRK IRON Co., Ltd., Falkirk.

*Potato chipper* to be fixed to edge of a table, for cutting potatoes quickly and evenly into chips for frying.

*Lent by*—STAINES KITCHEN EQUIPMENT Co., Ltd., Victoria Street, S.W.1.

*Porcelain-enamelled top table.*—It is claimed that the table is absolutely impervious to heat or moisture, and that it does not absorb stains and cannot warp. Water is prevented from running over by a patent bevelled raised edge. It has no crevices in which dirt or grease can harbour, and is easily kept clean.

*Lent by*—THE DEFIANT ENAMELLED TILE CO., Thames Iron Works, S.E.13.

*Dish washing machine,* washes and rinses dishes and other crockery. Water can be heated either by gas or by steam from works boilers. There is an interlocking arrangement between the doors and the operating handle to prevent washing or rinsing being done unless all doors are shut.

*Lent by*—THE HOBART MANUFACTURING Co., Ltd., London.

*Automatic tea measuring caddy,* measures out quickly and accurately a given quantity of tea into the teapot—ensuring equal quality of tea to each customer, preventing waste and saving time. The hopper will hold up to 5 lbs. of tea. It is fitted with airtight lid and with lock. A

single movement of the lower handle, to the right or left, delivers the requisite quantity of tea for one person. The measuring chamber is adjustable to suit individual requirements and, when adjusted, can be locked against any interference, ensuring that all customers get the same quantity of tea. The automatic register at the side indicates the number of teapots served.

*Lent by*—JACKSON BOILERS, Ltd., London and Leeds.

*Crockery and cutlery* of designs suitable for canteens.

*Lent by*—

J. FARQUHARSON & SONS, 59–64, Houndsditch, E.C,3.
THE LEADLESS GLAZE CHINA Co., 16 Belgrave Road, S.W.1.
JOSEPH GILBERT & SONS, Bissel Street, Birmingham.
BEATL SALES, Ltd., 1, Argyll Street, W.1.
THE PEEL-CONNER TELEPHONE WORKS, Ltd., Coventry.
DUNN BENNETT & Co., Ltd., Burslem.
CARR & Co., Ltd., Carlisle.

## Materials for covering Canteen Tables.

A and B.—*Oil baize*, easily wiped clean, does not crack and peel.

C and D.—*Rubber*, can be fixed with hardwood bead, similar to the linoleum shown on the table in the exhibit.

E, F and G.—*Linoleum*, patterned, similar to that shown on the small table exhibit.

*Lent by*—G. R. BYHAM & Co., Empire House, St. Martin's-le-Grand, E.C.1.

## Material suitable for covering Canteen, etc., Floors.

H.—*Composition flooring*, gives a smooth hard dustless surface, fire and vermin proof, and can be laid over floors of old or new wood, concrete or stone.

*Lent by*—F. SIDEBOTHAM, Ltd., 3/5, Macdonalds Lane, Manchester.

## Materials suitable for use in Canteen Shelves.

Plywood with a metal finish. Samples shown finished in copper, Monel metal and galvanised steel. Can also be used for counters and table tops, etc.

*Lent by*—VENESTA, Ltd., Vintry House, E.C.4.

## Bills of Fare.

Specimen bills of fare from a number of works in different parts of the country are shown in an album.

Notice board in canteen—steel background with frame and magnetised letters.

*Lent by*—WONDERSIGNS, Ltd., 235, High Holborn, W.C.1.

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## PHOTOGRAPHS.

Canteens, messrooms and kitchens ; " cook-houses " ; service hatch arrangements ; trolley services, etc., at various works ; with plans (Screens XXIII and XXIV and album).

Electrically-driven bread slicing machine with interlocked guards (Berkel & Parnall's Slicing Machine Mfg. Co., Ltd., Ponders End). (On table.)

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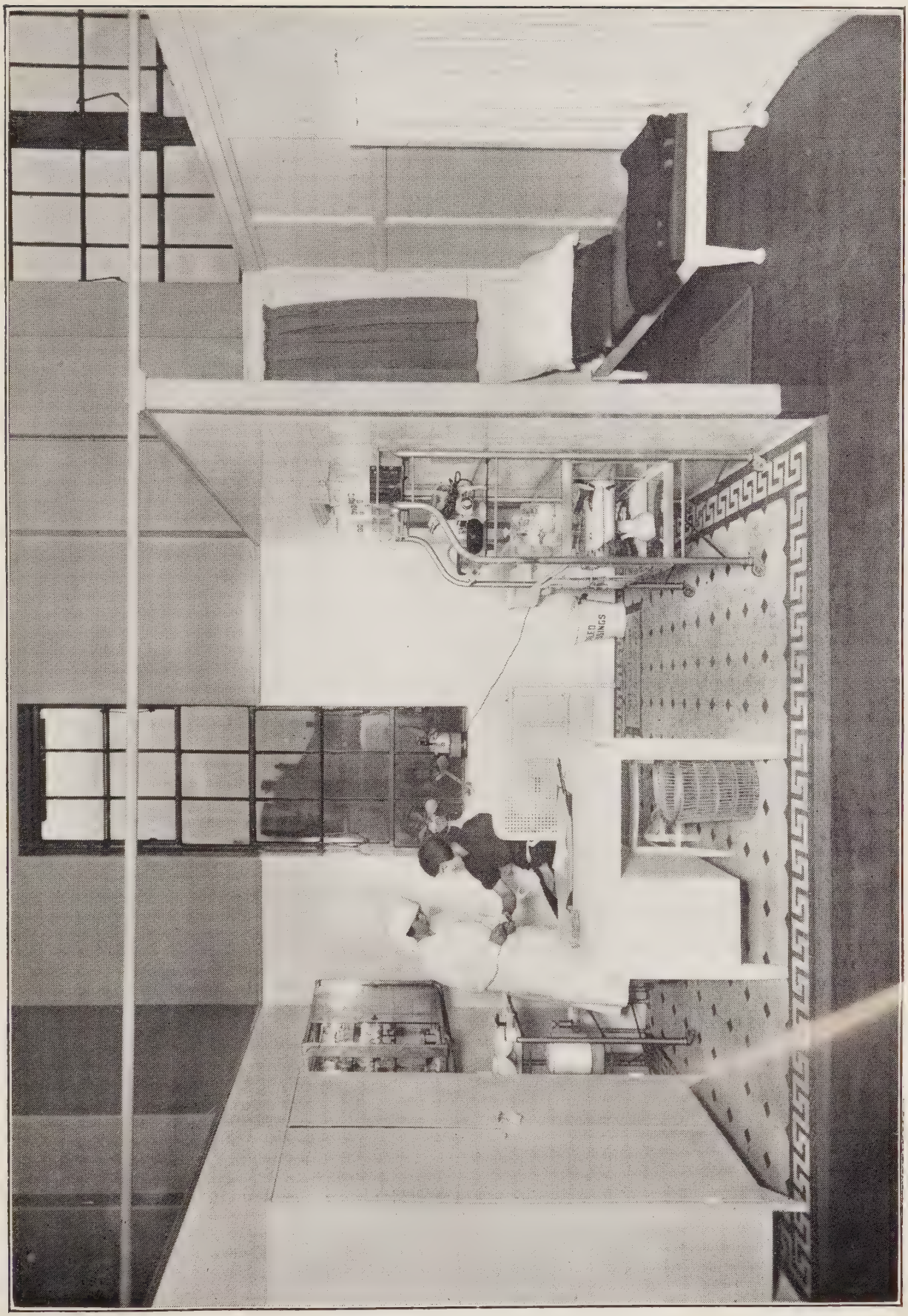
# FIRST AID AND AMBULANCE.

Arrangements for immediate treatment of injuries in factories are second in importance only to the arrangements for preventing them.

When an injury occurs, *even a trivial one*, it should be treated immediately. Everyone recognises the need of immediate treatment for a serious injury, such as a severe haemorrhage ; comparatively few appreciate the importance of attending at once to a minor cut or scratch. Neglect of a minor injury, nevertheless, even for a short time, may allow infection to take place, and sepsis or blood poisoning as it is commonly called, may follow, with the result that the worker may suffer a more serious and painful illness and be off work for a much longer period than

*To face p. 164.*



WELFARE SECTION.
Ambulance and Recovery Rooms.

if he had broken his arm or his leg. Thousands of such septic cases occur every year in the factories of the country and are the cause of a great deal of suffering and loss to the worker and loss of time and money to the employer. Not a few of these cases end fatally.

The remedy is *First Aid*, followed up by proper attention daily until the wound is healed.

The provision of *First Aid* arrangements is now required by law in all factories. They may take the form either of :—

(1) First Aid boxes stationed at convenient points in the workrooms ; or

(2) Ambulance rooms, if arrangements can be made to ensure the immediate treatment of any injured worker.

Both model First Aid boxes and a model ambulance room are exhibited. Fuller details will be found in the notices attached to the individual exhibits.

Provision of First Aid boxes in the workrooms or of an ambulance room will not be sufficient by itself. Three things are essential :—

(1) The equipment must be kept in good condition.

(2) There must be persons on the spot able to apply the dressing or other First Aid treatment when an accident happens.

(3) Workers must avail themselves of the treatment provided.

These will not be secured without care and organisation on the part of the management. The boxes, etc., must be regularly supervised by a competent person. Members of the staff must be encouraged to take courses of training in First Aid. Workers must be required and trained to come for treatment, however slight the injury.

In works where First Aid has been thoroughly organised in this way, remarkable results in the reduction of cases of *Sepsis* have been obtained.

## First Aid Boxes.

Various types of box are shown complying respectively with the two standards prescribed by the Home Office (*a*) for factories employing 50 persons or less, and (*b*) larger factories ; also *eyewash bottles*, as provided in chemical works in accordance with the Regulations. In Case H are :—

(1) The various types of sterilised *dressings* required to be provided in First Aid boxes at factories—the dressing having been removed from the outer wrapper and opened out to show the size and arrangement.

(2) Various forms of *applicators for Iodine*, which avoid the use of a brush and are much to be preferred.

(3) *Waterproof plaster* for covering a dressing, which is required by Home Office Orders in the case of certain industries where the process is a wet one.

A First Aid Outfit specially for dealing with splinters as used in cotton mills is on the table.

*Lent by*—J. WOOLLEY, SONS & Co., Ltd., Manchester.

## Ambulance Room.

This exhibit shows the following :—

(1) Dressings and lotions wagon.
(2) Aseptic wall cabinet.
(3) Aseptic dressings table.
(4) Examination chair.
(5) Linen and hanging cupboard.
(6) Nurse's desk and chair.
(7) Dressing and foot-bath stool.
(8) Lotion bottles, instruments, sterilised dressings and other accessories.
(9) Foot-bath.
(10) Lavatory basin with foot control valves and mixer.
(11) Tiled wall surface.
(12) Rubber flooring.
(13) Panel radiator.
(14) Orbit table fan.
(15) Container for soiled dressings—pedal operated.
(16) Electric sterilizer.

*Lent by*—

Exhibits 1 to 8 and 15–16. ALLEN & HANBURY, Ltd., Bethnal Green.
Exhibit 9. DENT & HELLYER, Ltd., 35, Red Lion Square, W.C.1.
,, 10. W. E. FARRER, Ltd., 39, Victoria Street, S.W.1.
,, 11. CARTER & Co. (London) Ltd., S.E.11.
,, 12. INDIARUBBER, GUTTAPERCHA & TELEGRAPH WORKS Co., Ltd., Silvertown.
,, 13. THE NATIONAL RADIATOR Co., Ideal House, Great Marlborough Street, W.1.
,, 14. VERITY'S, Ltd., King Street, W.C.2.

**Recovery Room.**

This exhibit shows :—

(1) A couch for resting or examination.
(2) A screen.
(3) A bowl with continuous flush.
(4) A blanket.
(5) Artificial daylight illumination.
(6) Hot water bottle with cover.

*Lent by*—
Exhibits 1 to 3 and 6. ALLEN & HANBURY, Ltd., Bethnal Green.
Exhibit 4. T. & D. LEE & SONS, Ltd., Earlsheaton, Dewsbury, Yorks.

Steel casement window.

*Lent by*—CRITTALL MANUFACTURING Co., Ltd. (Braintree), 210, High Holborn, W.C.1.

*Stretcher.*—Folding type stretcher with wheels.

*Lent by*—SIEBE GORMAN & Co., Ltd., S.E.1.

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## PHOTOGRAPHS.

First Aid arrangements, Ambulance Rooms, Dental Surgeries, Rest Rooms, etc., at various works (Screen XXV).

Welfare arrangements for persons employed in the open in herring curing (Screen XXV).

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## PROTECTIVE CLOTHING.

Special clothing for the whole or parts of the body is required in many industrial processes to protect the worker or the worker's ordinary clothing against wet, dust, extremes of temperature, grease, oil, acids ; cuts from handling sharp or rough edges ; burns from handling hot material, and other risks.

In a number of processes the provision of such clothing has already been made compulsory, and in many other processes where such provision is not compulsory, protective clothing is supplied by some employers who realise the need for protection of this kind.

This exhibit shows various types of protective clothing actually worn.

Case J.—Protection against wet, stickiness, oil and grease.

Case K.—Protection against dust and dirt.

Case L.—Types of masks and gauntlets for protection against risk of injury from bursting bottles in bottling of aerated waters.

Case M.—Protection against extremes of temperature. Face screens used by workers exposed to radiant heat.

Case N and detached figures by window.—Protection against fire, acids, alkalies, etc.

Case N1.—Protection of feet and legs against splashes of molten metal (Iron Foundries).

Case O.—Protection against hand and arm injuries and special types of aprons.

A short descriptive notice accompanies each exhibit.

*See also* revolving wall stand for photographs of protective clothing in use in tanneries, and exhibits of gloves in Dermatitis Section, Case H.

# TRAINING, REST PAUSES, RECREATION.

## PHOTOGRAPHS.

Arrangements at various works for :—

*Training young workers.*—Trade school (hosiery) ; initiation school (chocolate) ; physical culture (chocolate) ; camp school (chocolate) ; technical library ; day continuation school at factory (general education) ; mill training school (weaving) ; works training school (engineering) ; training centre (gas industry) ; training school (biscuits). (Screens XIV and XV.)

*Use of rest pauses during shifts,* e.g., drilling classes, garden. (Screen XXII.)

*Recreation,* e.g., works playing fields, reading rooms, games and recreation rooms, swimming baths (site of old slag heap utilised), factory gardens. (Screen XXVI.)

*References :—*

Industrial Fatigue Research Board's Reports, Nos. 25 (pp. 17–19), 32, 42 and 47 ; published by H.M. Stationery Office.

*BASEMENT.*

## CLOTHING ACCOMMODATION.

In industries where some or all of the workers on arrival at the factory have to change from ordinary clothes into working clothes, some place is needed in which the worker can keep his ordinary clothes during work hours and his working clothes after work is done.

In industries where the workers work in their ordinary clothes, accommodation is also needed—though usually of a less elaborate sort—for outdoor clothing ; particularly for outdoor clothing used in cold or wet weather. Most people will agree that it is desirable, in the interests alike of health and efficiency, that the workers should be able to work in dry clothes, and go home in dry clothes ; but, in fact, in many works, no provision at all is made for this.

There are many different ways of providing this accommodation, ranging from the specially fitted cloakroom or changing room provided in big factories or factories where some dangerous process is carried on, to an arrangement of lockers, racks with hooks or hangers, or, at the end of the scale, individual pegs.

Whatever the system adopted, the essential points to secure are :—

(1) That each worker shall, if the accommodation is not under his or her own eye, be assured as to the safety of his or her clothing and its separation from the clothing of other workers.
(2) That the accommodation should be perfectly clean and well-ventilated.
(3) That means of drying the clothing, if wet, should be provided.
(4) That the workers should not be delayed in getting their clothing when work is over.

There are, of course, other points which add to the comfort and welfare of the worker.

Limitations of space have made it impossible to exhibit a fully-equipped cloakroom or changing room, but photographs of such rooms in actual use at various works are shown on the Screens.

Of lockers, racks, etc., several different types and methods of arrangement are shown.

A wire basket for waste paper and rubbish, which is useful in a cloakroom, is shown.

*Reference* :—
Home Office Welfare Pamphlet No. 8, published by H.M. Stationery Office.

*Metal Locker for Clothing.*—These lockers are intended to form part of a range in two rows and to provide separate accommodation (numbered) for each worker. This type of locker can be used almost anywhere, in a cloakroom passage or workroom. The rising hinges secure that the door closes automatically and the rounded corners on the inside facilitate cleaning. Hot pipes would run below the lockers, which have a wire mesh at the bottom for the passage of hot air and another at the top to secure through ventilation. A fitting for a mirror is provided on the inner side of each door and a seat runs along the front of the lockers. As the lockers are raised above the floor, it is easy to clean below them.

*Supplied by*—RONEO, Ltd., London.

*Metal Locker for Clothing.*—These lockers are intended to form part of a range in two rows and to provide separate accommodation (numbered) for each worker, which he can keep locked. They have a sloping top which prevents rubbish being placed there and metal sides that can be easily washed. Hot pipes would run below, the bottom and top of the lockers being constructed to allow the heated air to circulate freely upwards. A fitting for a mirror is provided in each locker. In front of each row is a seat for worker's use. As the lockers are raised above the floor, it is easy to clean beneath them.

*Supplied by*—RONEO, Ltd., London.

*Cupboard for Clothing.*—A type of cupboard specially useful where provision has to be made for a small group of workers. It would stand on a landing, in a passage or in a workroom. Hot pipes would run through the bottom, the rack above them preventing contact with clothing, but permitting free passage of hot air for drying. The upper part of the doors is of wire mesh to allow through ventilation, but the rest of the cupboard is constructed to keep out dust. Coat hangers are provided in the hanging space; the top shelf accommodates hats and the side shelves boots. The cupboard can be kept locked when the workers are not present.

*Metal Locker for Clothing.*—This locker has a ventilation disc at the bottom and also at the top of the door, so that air passes up vertically through the clothing hanging in it. The mirror on the top is set at an especially convenient angle.

*Supplied by*—CALEB WRIGHT & Co., Tyldesley.

*Metal Locker for Clothing.*—These lockers are intended to form part of a range and to provide separate accommodation (numbered) for each worker. Each locker is fitted with a bolt as well as lock. The lockers

are raised from the ground so that hot pipes could be run below them. Holes in the metal bottom of the locker allow passage of heated air and the louvres in the door secure through ventilation. A shelf is provided for hats or parcels and a clip on the outside of the door for umbrella. This clip is fastened by a catch on the inner side and can therefore only be operated when the locker is opened.

*Supplied by*—JAMES GIBBON, Ltd., Wolverhampton.

*Rack for Clothing.*—A convenient method of providing accommodation for clothing on wall space in a workroom or in a cloakroom. This arrangement keeps the coat in shape and allows it, if wet, to dry easily. The coats and hats are kept well away from the wall and there is a good space between each set of clothing.

*Supplied by*—R. G. WHITAKER, Ltd., Kingston-on-Thames.

*Wire Racks for Clothing.*—A convenient method of providing clothing accommodation on wall space or on a pillar in workroom or passage, particularly where the wall is damp. Wire netting is fixed at a slight distance from the wall or round the pillar and pegs fastened to it.

*Supplied by*—JOHNSON, CLAPHAM & MORRIS, Ltd., 46, Victoria Street, S.W.1.

*Lifting Clothes Racks, Lifting Clothes Hooks,* which can be pulled up out of reach. An arrangement which is inexpensive and specially suitable for use where space is a consideration, e.g., in a room which is used for other purposes, such as washing accommodation, or in the workroom itself. If the room is warm, the clothing will dry readily. The Rack is fitted with hangers for clothing and hats or parcels can be placed on the top of it. Each Clothes Hook has a check device which prevents it touching the ground if the rope is let go.

*Lifting hooks lent by*—GUMMERS, Ltd., Rotherham.

*Rack for Clothing.*—Suitable for use in a cloakroom or in any situation where it is not essential to keep clothing under cover to avoid contact with dust or dirt of any kind. A hot pipe would run below to dry the clothing when wet. There is a separate peg for each worker, a shelf at the top for hats or parcels, and bars at the bottom for boots or shoes. A seat at each side enables workers to change their boots or shoes quickly.

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## PHOTOGRAPHS.

Cloak-rooms, changing rooms, lockers in workrooms, in various works are shown on wall screens.

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# WASHING AND SANITARY CONVENIENCES.

The provision of washing accommodation in factories has been made compulsory in a number of industries where either—

there is a risk of poisoning or dermatitis from the materials handled, or the work is hot, dirty, or disagreeable.

While not compulsory in factories generally, its provision is strongly recommended as a welfare arrangement and many employers have provided such accommodation voluntarily, or would desire to provide it if they felt that the workers would appreciate its use.

It is certain that many workers, from considerations of health and self-respect, value an opportunity of washing when they leave off work and before taking a meal or going out into the streets, and if good and suitable arrangements are provided will make use of them.

A good deal will depend on the washing facilities being conveniently situated for the workers. In a number of works, the plan of scattering the facilities about the works instead of concentrating them in one or two large lavatories, has been tried with success. Examples of these are shown in photographs.

The arrangements should include at least—

(*a*) *Fitted basins or troughs* with a constant supply of warm or hot and cold water laid on. Three types are shown in the exhibit :—

(i) Circular basin for six persons, designed to occupy only a small space. Hot and cold water are supplied to the central chamber. A separate spray controlled by pedal is provided for each person. The trough is without plug, so that each person uses clean water.

*Lent by*—DENT & HELLYER, Ltd., 35, Red Lion Square, London.

(ii) Circular wash-basin with pedal control for the water supply. This type of basin will enable nine or ten persons to wash simultaneously. Liquid soap deliverers are also provided. Hot and cold pipes are connected at the top of the fountain and the pipes are easily accessible for maintenance, etc.

*Lent by*—W. E. FARRAR, Ltd., 39, Victoria Street, S.W.1.

(iii) Double-sided trough for six persons. The water supply is controlled by the foot—an arrangement suitable for works such as food factories, where a high standard of cleanliness is required, as taps operated by hand are apt to get dirty and to soil the hands of the workers after they have been washed.

*Lent by*—W. E. FARRAR, Ltd., 39, Victoria Street, S.W.1.

(*b*) *Soap receptacles or distributors.*—Soap in the form of liquid, powder or jelly is found more suitable than tablets for use in factories. Various types are shown in the exhibit.

*Lent by*—
THE BERSEL MANUFACTURING Co., Lawrence Rd., N.15.
THE HORTON MANUFACTURING Co., Rickmansworth.
LONDON OIL PERFUMERY Co., Welwyn Garden City.
TARPERS, Ltd., 1, Holborn Buildings, E.C.1.

(*c*) *Towels.*—Small towels about 12 in. square are the best, but as these are liable to be lost, unless special arrangements are made to prevent this, absorbent paper towels have been found convenient and inexpensive. There is no hygienic objection to roller towels if large enough for each person to be able to draw upon a clean portion.

*Arrangement to prevent pilfering of individual towels.—Lent by*
GREAT WESTERN RAILWAY Co., Swindon.

*Paper-towel distributors lent by—*
D.M.A. Co., Ltd., Leicester.
BRITISH PATENT PERFORATED PAPER Co., Hackney, E.9.

*Mechanical Towel Cabinet lent by—*
THE INITIAL TOWEL SUPPLY Co., E.C.1.

(*d*) *Electric hand drier.*—Hot air hand drier for use in factories. A convenient and practical alternative to providing and maintaining an adequate supply of individual towels and obviating the use of the same towel by a number of persons. It must, however, be pointed out that the risk of dermatitis from this method of drying the skin, especially if imperfectly freed from soap suds, is not entirely negligible.

It is recommended that where electric driers are used the following points should be borne in mind :—(1) There should be a sufficient number of driers, say about one to every five persons washing at a time ; (2) the skin should be thoroughly rinsed in clean water before drying. The risk of the suds adhering to the skin, as may happen where a wash-basin with plug is in use by a number of persons, can be obviated by providing a spray, thus ensuring a flow of clean water for rinsing. An ointment of vegetable oil may with advantage be used from time to time to counteract the degreasing action on the skin of a current of hot air.

*Lent by*—LANCASHIRE DYNAMO & CRYPTO, Ltd., Westminster, S.W.1.

(*e*) *Nail-brushes*, chained to the basin, or fixed to the wall or back ledge of the basins. A circular brush, as shown in the exhibit, is found to have a longer life than the ordinary oblong shape, as the wear is more evenly distributed over the whole surface.

*Lent by*—CADBURY BROS., Ltd., Bourneville.

(*f*) *Ointment dispenser.*—Application of ointment before and after work is recommended in some industries for the prevention of dermatitis. (*See* Dermatitis, page 146.)

*Lent by*—ROZALEX, Ltd., Cross Street, Manchester.

## PHOTOGRAPHS.

Lavatories, washing arrangements in workrooms, baths (foot, shower, etc.) in various works are shown on wall screens.

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## Baths.

In certain dangerous trades the provision of baths is made obligatory by law, but outside these trades individual employers have for many years, and in increasing numbers, provided baths voluntarily for the use of their workers, and in hot, dusty, or dirty trades the provision is not only appreciated by the workers, but conduces greatly to their health and efficiency.

The advantage which results to the worker's home is also worth consideration. A bath at the factory reduces the work of the housewife.

Photographs of bath installations at various factories will be found on the wall.

A model of a shower bath is exhibited to show how provision can be made simply and without occupying much space. The design secures privacy. Two sets of shower bath fittings are shown, with mixing valves to control the temperature and supply of water. In one case the key of the valve can be detached by the attendant to prevent interference by unauthorised persons. In the other case the spray can be tilted at various angles so that the bather need not wet the hair.

*Lent by*—

THE LEEDS FIRECLAY Co., Ltd., 2, Cavendish Place, W.1.
DENT & HELLYER, Ltd., 35, Red Lion Square, W.C.1.
GUMMERS, Ltd., Rotherham.

## Sanitary Conveniences.

Two types of convenience are shown, one to form part of a range and the other suitable when the convenience adjoins the workroom.

In the first, attention may be drawn to the following points :—

(1) The walls are made of material which can be washed down and on which scribbling is difficult.

(2) The space below the partition allows thorough cleansing of the floor of the range.

(3) The floor is rounded off to the wall leaving no angles in which dirt and dust can accumulate.

(4) A hygienic " non-contact " seat is provided.

(5) The door has an inside fastening.

In the second, the following points should be noticed :—

(1) An intervening ventilated space is provided between the door of the convenience and the door leading to the workroom, as required by the Home Office Order.

(2) The partitions are carried up to the ceiling to ensure complete separation from the workroom.

(3) A window at the back provides separate ventilation for the convenience.

(4) Artificial light is provided in addition to the natural lighting from the window.

(5) The flushing mechanism, including chain or rod, is enclosed so that it cannot be tampered with by unauthorised persons, and is operated by a sliding knob.

*Lent by*—

DENT & HELLYER, Ltd., 35, Red Lion Square, W.C.1.
THE LEEDS FIRECLAY Co., Ltd., Leeds.
ART PAVEMENTS AND DECORATIONS Ltd., St. Paul's Crescent, N.W.1.

*Section of corrugated slate partition lent by*—JOHN EVANS Ltd., 88, Soho Street, Liverpool.

An opaque glass partition is also shown, consisting of two sheets of rough-cast glass placed together with the smooth surfaces outwards ; easy to clean and difficult to scribble upon.

*Lent by*—MORRISON INGRAM & Co., Manchester.

*Reference* :—

Home Office Welfare Pamphlet No. 8 (" Cloakrooms, Washing Facilities, Drinking Water and Sanitary Accommodation "), published by H.M. Stationery Office.

## DRINKING WATER.

Drinking fountains of the jet type rendering cups unnecessary are shown on the ground floor by entrance, in the clothing accommodation section in the basement, in the canteen in the gallery, and in the lavatories in the basement where a combined bib cock and drinking fountain is fitted.

*Lent by—*

SHANKS & Co., 81, New Bond Street, W.1.
GEORGE TAYLOR, Ltd., Belle Isle, York Road, N.7.
WILLIAMSON & Co., 13, Coupar Street, Dundee.

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## VENTILATION OF FACTORIES.

### *"VENTILATION" ROOM.*

Adequate ventilation, by which is meant the maintenance of a pure, fresh atmosphere, is now generally recognised as essential for health and efficiency, whether in the factory, the home, or other place where men or women pass a considerable portion of their lives; though in this, as in other matters, practice often lags far behind theory.

In the manufacturing industries, where work is usually carried on indoors, and numbers are often employed in close association, the need of good ventilation is specially great and is recognised in the statutory requirements of the Factory Acts. In many of these industries the need is intensified by the conditions incidental to the process carried on, e.g., by dust, gases or fumes given off, high temperatures, excessive humidity (particularly when associated with high temperatures), etc. Dust and fumes given off in the manufacturing process should, whenever and as far as possible, be removed by means of "exhaust" ventilation applied at the spot where they are given off—and this is being more and more

widely done in industry. Many examples of such arrangements will be found in the Museum. *Complete* removal by such means is, however, in many cases impossible, and they require to be supplemented by a high standard of general ventilation.

Adequate *general* ventilation depends on two things :—

(1) *Movement of air.*

(2) *Change of air.*

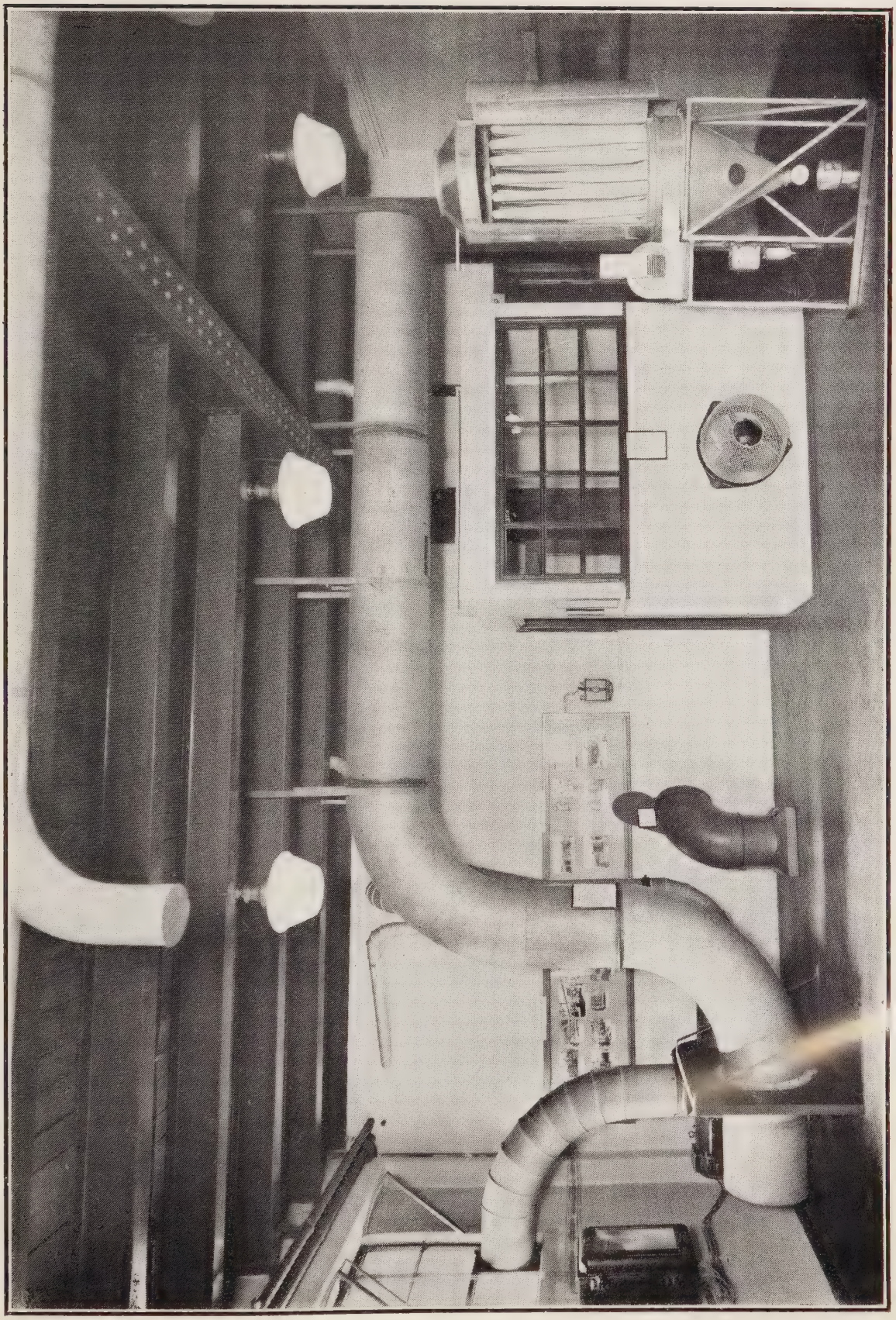
Under normal conditions, the general ventilation of factories is usually effected by natural means (e.g., windows, wall openings, skylights, chimneys, air shafts, etc.), in some cases assisted by appliances operated by the wind, e.g., roof cowls. The adequacy of natural ventilation depends largely on the ventilating openings being of sufficient area and well distributed.

Natural ventilation, however, whether assisted by the wind or not, often fails even under ordinary conditions to give satisfactory results. It depends for its efficiency on the full use of the means provided, which, although possible in warm weather, is not so when cold or chilly conditions prevail and openings are liable to be closed to avoid draughts or to maintain temperature. This tends both to vitiation and to stagnation of the air.

Modern research has shown that stagnation of the air (and this may exist under other conditions besides those just mentioned) is of not less importance, perhaps of more importance, than vitiation. Formerly, a room was considered to be satisfactorily ventilated if the proportion of carbon dioxide did not rise above a certain point. Physiologists now stress the necessity of air movement if the conditions most favourable for industrial efficiency are to be maintained—the effect of air movement is to increase its " cooling " power and so prevent strain being thrown on the heat-regulating mechanism by which a healthy body maintains normal body temperature. In a large and lofty workroom, allowing a large air space per worker, the air may be comparatively pure, but quite deficient in cooling power, and this condition is intensified where high temperatures and excessive humidity prevail. The instrument, called the Katathermometer, which will be found in the Ventilation Room, has been devised for the measurement of the cooling power of the air of a room.

*Movement of air* in workrooms can be obtained locally by the use of bench and other types of electric fans, portable or fixed, wafters on shafting, etc. Local ventilation defects in large rooms can often be corrected by such means. Examples of such fans will be found distributed over the Gallery and in the Lecture Room.

*To face p. 178.*



PART OF VENTILATION SECTION.
On right "Waring" Dust Collector.

*Change of air* of workrooms may be effected mechanically in several ways, of which the chief are :—

(1) Forcing fresh air into the room (" Plenum " system).

(2) Extracting the vitiated air from the room (" Exhaust " system).

The " Plenum " system is usually favoured as being the more economical. Fans of centrifugal type force the air through ducts, provided with openings at selected positions, which distribute the air supply. During part of the year it is necessary to warm the incoming air to prevent cold draughts and to assist in maintaining a suitable temperature.

The " Exhaust " system has the advantage that extraction may be effected in many ways and may be used where fumes or light floating dust are present throughout the room and cannot be otherwise removed. On the other hand, with this system the maintenance of a proper temperature in the workroom presents a more difficult problem, as the incoming air will enter at any available inlet and cannot all be warmed on entry, as is possible with the " Plenum " system. The type of fan known as the " Propeller " is very suitable for the purpose, *except* where ducts have to be used. The special conditions for the use of this type of fan are illustrated by the exhibit in the " Ventilation " Room.

Where ducts are used, their correct design is essential to efficiency. An exhibit is provided in this Room to allow the performance and efficiency of a well-designed duct to be compared with that of one badly designed. *See* below.

*References* :—

Home Office Welfare Pamphlet—" Ventilation of Factories and Workshops."
Reports of Industrial Fatigue Research Board :—

No. 1. " Influence of Hours of Work and of Ventilation on Output in Tinplate Manufacture."

No. 11. " Preliminary Notes on Atmospheric Conditions in Boot and Shoe Factories."

No. 35. " A Physiological Study of the Ventilation and Heating in Certain Factories."

No. 37. " Fan Ventilation in a Weaving Shed."

*Fans in Gallery lent by—*

GENERAL ELECTRIC Co., London.
VERITY'S, Ltd., London.
CABLE ACCESSORIES, Ltd., Tipton, Staffs.
METROPOLITAN-VICKERS, Ltd., Manchester.

## Mechanical Ventilation.

### Design of Ducts.

This exhibit has been designed to illustrate :—

(1) The principles of an efficient system of mechanical ventilation when ducts have to be employed.

(2) The loss of *efficiency* and consequent increase in working *cost* caused by defective duct design.

Inefficiency is mainly due to eddies set up in the air stream. These are caused by various defects, e.g., square or other sharp bends in the ducts, abrupt alterations in section, junction of branches with main duct at abrupt angles, obstructions or projections inside ducts, and joints directed against instead of with the air stream.

The volume of air moved is reduced by the presence of an eddy or swirl, owing to the circular motion imparted to the pocket of air in the eddy. Virtually, an eddy reduces the cross-sectional area of the duct and increases the resistance.

The exhibit consists of two ducts, each 45 ft. long, one correctly designed and the other incorrectly designed. The average cross-section is the same in both, and the two ducts were designed to contain equal amounts of metal of the same gauge, so that the cost of metal used was the same in both. Either duct can be connected as desired to the motor-driven cased fan capable of wide variation in speed. By an arrangement of valves, the air can be directed along the ducts in either direction, making the duct a plenum or suction duct as desired. Instruments are provided for measuring the power consumption and air volumes moved at different fan speeds.

Tests made with the measuring instruments indicate :—

(i) That the power required for moving a quantity of air through the badly designed duct is much greater than that required for moving the same quantity of air through the well designed duct. The Graph adjacent shows the relationship between power and output for the two ducts respectively, the values being expressed as percentages of the maximum for the efficient duct. Taking, for example, the figures for an air velocity frequently adopted in good practice, the proportion is about 2 to 1, as shown by the red line.

(ii) That the inflow and delivery of air at the openings of the various branches of the badly designed duct show wide variations, the well designed duct on the other hand giving much more uniform results.

The exhibit was designed, and the tests on which the curves are based were carried out, by a Committee of the Institution of Heating and Ventilating Engineers, in consultation with the Home Office.

## Propeller Fans.

This exhibit is designed to demonstrate the conditions under which fans of the propeller type can be used with efficiency. It consists of ; (1) an 18 -in. diameter motor-driven fan, capable of being run at different speeds in either direction ; (2) 50 ft. of duct of 19 in. diameter ; and (3) an adjustable shutter at the end of the duct remote from the fan, which can be used to reduce the area of the discharge from the duct to any degree.

In general, this type of fan is suitable only for use under the conditions of free intake and free discharge of air, i.e., when the resistance to the air flow is negligible. A smooth, uniform and comparatively short duct (as in the exhibit), the cross-sectional area of which is not less than that of the fan, and in which the bends (if any) are few and well designed, offers only slight resistance, and a propeller fan can be used with such a duct with little loss of efficiency. On the other hand, considerable resistance is offered by narrow ducts, or ducts which contain sharp bends, or vary abruptly in area, and in these cases a propeller fan is inefficient—the air propelled forward by the rapidly moving tips of the fan blades tending to return through the centre of the fan. In the exhibit the effect of narrow ducts can be produced by varying the area of discharge, and the fan can thus be tested against different measurable resistances.

The curves in the Graphs show the results of a series of tests carried out with this exhibit with varying resistances. Graph I demonstrates the inefficiency of a propeller fan when used with small ducts. Graph II demonstrates the important point that the power consumed does not decrease as the output falls, but, on the contrary, tends to increase.

The exhibit was designed and the tests were carried out by a Committee of the Institution of Heating and Ventilating Engineers, in consultation with the Home Office.

*Fan lent by*—JAMES KEITH & BLACKMAN, Ltd., Farringdon Avenue, E.C.4.

## Dust Removal System for Metal Grinding and Polishing Machinery.

This exhibit shows a well designed dust removal plant for the grinding and polishing machinery installed on the floor above. The exhibit comprises on this floor :—

(1) The main suction duct and the connections to it of the branch ducts leading from the machines.

(2) The cased fan.

(3) The discharge duct which is connected to the cyclone separator outside the building.

Important features in the design, tending to efficient and economical working, are the following :—

(*a*) The main suction duct is straight and centrally placed in relation to the branch ducts—unnecessary length of ducts being thus avoided. The main duct is increased in size, at the points where branches join, by gradually tapered lengths.

(*b*) Each branch duct is connected at a small angle with the main duct, in the direction of the air flow.

(*c*) Junctions of branch ducts with the main duct are, in general, not placed directly opposite each other, the creation of eddies being thus avoided.

(*d*) The bends in the main suction and discharge ducts are very gradual.

(*e*) The joints are so made that the internal edges do not obstruct the air flow.

(*f*) The main suction duct is connected with the inlet to the fan by a suitably tapered piece.

(*g*) Doors are provided in the main suction duct to facilitate cleaning.

*Lent and installed by*—JAMES KEITH AND BLACKMAN, Ltd., Farringdon Avenue, E.C.4.

*Manometer (in grinding section) for testing air pressure, lent by*—
WEBB DUST REMOVING & DRYING Co., Stockport.

## Dust and Chip Removal Plant for Woodworking Machinery.

This exhibit shows a modern, well designed dust and chip removal plant for the woodworking machinery installed on the floor above. The exhibit comprises, in this room and in the adjoining workshop :—

(1) The main suction duct and the connections to it of the branch ducts leading from the machines.

(2) The cased fan.

(3) The discharge duct which is connected to the cyclone separator outside the building.

Important features in the design, tending to efficient and economical working, are the following :—

(*a*) Special junction pieces connect the branch ducts to the main duct. These are well designed so as to provide the necessary increase of size at the junctions and to ensure that the flow of air from the branch joins that in the main duct at the smallest possible angle. The three-way junction (that nearest the fan) is the most interesting example.

(*b*) The bends in the suction and discharge ducts are very gradual.
(*c*) The joints are so made that the internal edges do not obstruct the air flow.
(*d*) The interceptor box in the main duct near the inlet of the fan, by "breaking" the continuity of the duct, intercepts and retains any nails or other metal which may be carried by the air stream from the machines and which, if passed through the fan, might injure the blades.
(*e*) Doors are provided in the ducts to facilitate cleaning.

*Lent and installed by*—STURTEVANT ENGINEERING Co., 147, Queen Victoria Street, E.C.4.

## Removal of Fumes by General Mechanical Ventilation.

This exhibit shows a suitable method of protecting workers engaged on work in which heavy noxious fumes are produced but the conditions of which make the application of localised exhaust arrangements for their removal impracticable. The method consists in drawing large volumes of fresh air from behind, and past, the worker so as to dilute the fumes as they arise and sweep them away from the worker. The work-bench is placed alongside an external wall; a propeller fan is installed in the wall below the bench and exhausts through the air passages (which are protected by open mesh grids) at the back of and below the bench; the fresh air enters at a large inlet (or inlets) overhead and behind the workers. (In actual practice, the fresh air would be drawn from outside the building and warmed by passing it through a battery of steam or hot water pipes, or through gilled heaters, placed near the inlets; and the fan would discharge into the open at a point away from windows or other openings, so that the fumes could not re-enter the building. For long rooms, additional fans and inlet openings would be required, spaced at suitable intervals.)

The electric motor driving the fan and the controlling switch are of the enclosed type; this is desirable where the fumes are of an inflammable or explosive nature.

*Fan lent by*—THE GENERAL ELECTRIC Co., London.
*Switch lent by*—LUCY & Co., Oxford.

## Lobster-back Roof Ventilator.

A form of roof outlet ventilator with a revolving cowl, which is constructed so as to turn readily with each change in the direction of the wind. A large oil reservoir provided for the footstep bearing ensures continuous lubrication for a long period.

*Lent by*—THE POTTERIES VENTILATING AND HEATING Co., Tunstall.

## Roof Ventilators.

Small scale apparatus for studying the behaviour of different types of roof ventilators under varying conditions : (1) of wind direction ; (2) of pitch of roof.

The purpose of roof ventilators is to enable the warm and lighter, vitiated air which rises to the roof to escape readily from the building, and the arrangements should be designed to utilise as much as possible the aspirating or inductive action of wind to increase the upward current.

It is common experience that arrangements which under favourable wind conditions will function efficiently, under other conditions give unsatisfactory results, or even permit of a reversal of the air current which will drive the vitiated air back into the building and produce objectionable draughts.

The apparatus consists (1) of a chamber, representing a building, with an inlet opening at the side, and on the top an outlet opening to which can be fitted models of roofs and ventilators ; (2) of a short tunnel through which an air current created by an electric propeller fan, can be directed against the roof and ventilators.

Models of various types of ventilators are provided for use on the apparatus, some of them having a roof attached, the pitch of which can be increased or diminished. The angle at which the air current is directed against the roof and ventilator can also be varied by rotating the chamber.

The effects on the air movement in the chamber produced with different types of roof ventilator by changes in wind direction and pitch of roof can be demonstrated by a small anemometer fitted over the inlet opening of the chamber. Lighted smoke-paper may also be used.

The roof ventilator models are carefully proportioned to scale. They include—

(*a*) Two double-sided ridge louvre ventilators, one fitted without flanges to the louvres, the other with flanges which operate to prevent as far as possible the considerable down-draughts which are experienced, in unfavourable circumstances, without them ;

(*b*) " Robertson " ventilator, modern circular type, fitted with large wind shield and otherwise constructed to reduce down-draught to the greatest possible extent ; and

(*c*) Ordinary chimney " down-draught " preventer.

*Apparatus designed by*—H. H. ROBERTSON & Co., of Clutha House, Princes Street, S.W.1., who have given permission for its exhibition in the Museum, and lent the " Robertson " ventilator model.

## "Waring" Dust Collector (Model).

In processes where lead or other poisonous dust is generated and drawn off from the workrooms by an exhaust ventilation system, it is desirable that the dust should be collected at the point of discharge to prevent the pollution of the atmosphere in the vicinity of the workrooms and to avoid the loss of material, which may have a commercial value. The ordinary cyclone separator, or dust collector, allows an appreciable amount of extremely fine dust to escape into the air, and some filtering arrangement is needed. The model exhibited shows a method of trapping the fine dust which has been adopted at the lead works of Rowe Bros. & Co. (Bootle), Ltd., Bootle. The incoming air escapes up through the bag filters while the dust is arrested by the fabric and falls into the chamber below. For detailed description, *see* notice.

A photograph is shown on Screen XI (Gallery).

*Lent by*—FRASER & CHALMERS, Erith, Kent.

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## Recording Katathermometer.

The katathermometer is an instrument for measuring the cooling power of the air of a room. A specimen of the ordinary type of katathermometer, which was invented by Professor Leonard Hill, F.R.S., is in Case W (in Gallery). The recording instrument here shown has been developed from it by Dr. Edgar Schuster. (The actual katathermometer connected with it is in the demonstration building in the yard—*see* page 187).

Research in recent years has shown that—quite irrespective of whether or not the air of the room is polluted by dust or fumes from the manufacturing or other processes carried on—inadequate ventilation causes the air of a room to become overheated and stagnant which has depressing and enervating effects that are inimical to sustained work. These conditions are popularly called "lack of air" and "stuffiness"—terms which indicate the prevalent idea of pollution of the air. This popular idea has now been proved to be a mistaken one, and we know that the bad effects of such "stuffy" atmospheres can be removed by lowering the temperature or by causing the air to move.

The katathermometer was accordingly designed to measure the power of the air to cool an object at the temperature of the human skin and by this method to determine the adequacy of the air movement in a room. In the recording instrument here shown the thermometer is heated electrically to about the temperature of the skin; when this temperature is reached

the heating circuit is automatically broken, and the thermometer then allowed to cool through 5° Fahrenheit; when the cooling period is completed the heating circuit is again automatically made, and the process is repeated. The time of each cooling period is recorded by the pen as an ordinate of a curve; the longer the ordinate the longer is the time of cooling. A very long time indicates a badly ventilated room.

Suitable cooling powers for workrooms in factories vary from 6 to 8 millicalories per square centimeter per second. Cooling powers of 3·0 to 4·0 are often found in such places as laundries, showing conditions where really efficient work is almost impossible; cooling powers of 9 and over indicate conditions that are too cold for anything but hard physical exercise.

The instrument can also be used to show the great increase in cooling power of the air that can be produced by causing the air to move. If the fans near the recording instrument are set in motion it will be observed from the shortening of the cooling-time lines that a great increase in cooling power has taken place; showing that stuffiness in a building can usually be reduced by the use of suitable fans to stir the air.

*References :—*

Report of Medical Research Committee, No. 32, Parts I and II, "The Science of Ventilation and Open Air Treatment." Leonard Hill, F.R.S.

Report of Medical Research Council, No. 73, "The Katathermometer in Studies of Body Heat and Efficiency."

Report of Medical Research Council, No. 100, "Methods of Investigating Ventilation and its Effects." H. M. Vernon and others.

Journal of Industrial Hygiene IV, No. 11. (American.) "The Ventilation of English Factories and Workshops in Hot Weather." T. Angus.

"Health and Environment," by Leonard Hill and Argyll Campbell-Arnold 1925.

## PHOTOGRAPHS.

Methods of general and localised ventilation in the following industries and processes :—woodworking, jute, rope works, flax and tow, cotton, aeroplane doping, india-rubber, printing, metal grinding, polishing and smithing, tinning, galvanising, founding, rumbling, cellulose spraying, soldering, dyeing, brushmaking.

Cool air supply in hot processes (glass, tinplate).

*IN YARD OUTSIDE.*

## Cyclone Separators or Collectors.

(*See* also pages 181 and 182.)

The collector consists of (1) a galvanised sheet metal casing in two parts, both conical in shape, set base to base ; (2) a slightly tapered air-discharge trunk of sheet metal, within the upper part of the casing. A spiral plate spans the space between the casing and the trunk down to a certain point and is then continued as a narrow ledge on the inner surface of the casing.

The dust-laden air enters the collector tangentially through the side opening near the top, is given a circular motion within the collector, which causes the dust and chips to fly towards the inner surface of the casing, and is guided downwards along the spiral path ; its speed gradually decreases owing to the increasing diameter of the collector and the dust and chips are directed to the bottom of the casing where they fall through the orifice into a collecting sack or chamber. The dust-free air, on the other hand, passes up the vertical trunk and escapes through the opening at the top of the collector into the atmosphere.

A sectional view is shown in the Ventilation Room.

*Supplied by*—STURTEVANT ENGINEERING Co., Ltd., London, E.C.
JAMES KEITH & BLACKMAN, Ltd., London, E.C.4.

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# AIR CONDITIONING PLANT.

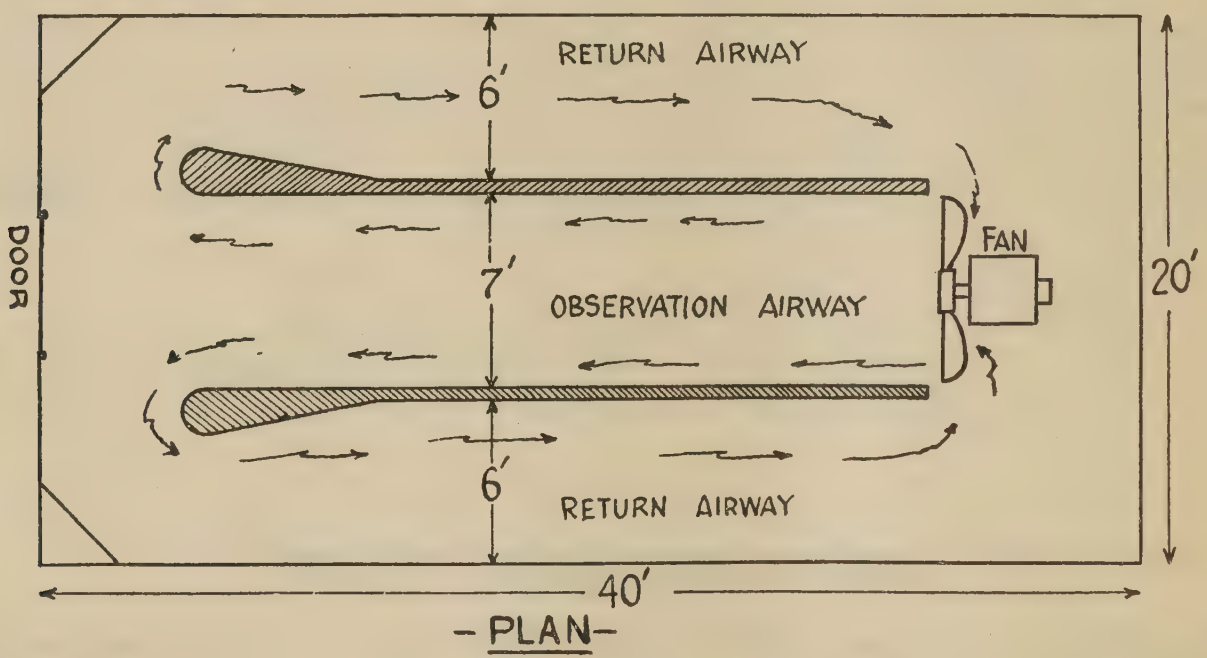
## Building for Demonstrating Effects of Atmospheric Conditions in Workrooms.

The building has been specially designed and equipped to reproduce unfavourable atmospheric conditions such as are experienced in various industries, to show what are the physical and physiological effects of these conditions on the worker, and methods by which the conditions can be remedied or their effects mitigated.

The arrangements provide for ventilating the building by regulated air movements, for heating by convection or radiation (electric panel heaters being used for the latter purpose), and for artificially humidifying the air to saturation, or to any required degree of relative humidity, over a wide temperature range. Thus widely differing conditions can be attained, e.g. the warm, humid conditions of cotton weaving sheds, the steamy conditions of laundries and dye houses, the hot conditions

associated with furnace work, the more normal atmospheric conditions of ordinary workrooms, and also, when the external temperature permits, the cold conditions of insufficiently warmed workrooms.

The air changing, heating and humidifying apparatus are of sufficient capacity to enable conditions to be readily changed for observation purposes. Modern scientific instruments (*see* below) are provided to enable accurate measurements to be made of the physical characteristics under observation. It is hoped that the building will prove of particular service to factory occupiers and managers, heating and ventilating engineers, architects and others concerned with the ventilation and heating of industrial premises.




—PLAN—

The building comprises a room 40 ft. long, 20 ft. wide and 8 ft. high, with a flat ceiling, and subdivided lengthwise into three sections by two walls reaching from floor to ceiling but not extending the whole length of the room. At one end of the central corridor, which is designed to serve as an observation airway, is a large fan (60-inch variable speed propeller, electrically driven) (*see* separate notice). When the doors and windows of the building are closed, the air propelled by the fan along the central corridor circulates back to the intake of the fan through the outer part of the room on both sides of the central corridor, the outer part thus forming two return airways. The air in the room, instead of being circulated in this way, can be rapidly changed by opening a large sliding door in the ceiling above the intake side of the fan and doors leading out of the other end of the room.

The plant includes besides the fan :—

(*a*) *For Heating.* Electric heaters of non-luminous type effecting :—

(i) heating of the air : heaters taking a total input of 32 kilowatts are installed in the return airways.

(ii) heating by radiation : panel heaters, high and low temperature, taking a total input of 7 kilowatts, are installed in the observation airway. (*See* separate notices.)

(*b*) *For Humidifying.* Steam spray fittings are provided at suitable positions in both the observation and return airways ; the sprays are supplied with low pressure steam from a small gas-fired vertical steam boiler installed in an adjoining boiler house.

The scientific apparatus includes :—

(*a*) Dry and wet bulb thermometers ;

(*b*) A Sling psychrometer by means of which the wet bulb temperature and the humidity can be more quickly and accurately ascertained than by the ordinary wet bulb thermometer which is affected by air movements or their absence ;

(*c*) Katathermometers, for measuring the atmospheric cooling powers ; the Schuster instrument (*see* page 185) is used for securing a continuous record of the cooling powers during observations ;

(*d*) Anemometer, for measuring air velocities ; and

(*e*) " Moll " Thermopile and Galvanometer, for indicating the intensity of radiant energy from various sources (*see also* separate notice).

*Demonstrations.* It is not possible within the limits of this note to describe fully the demonstrations which can be made with the plant and apparatus now available. Some indication, however, is given as follows :

(*a*) *At ordinary temperatures,* 62° *to* 65° *F.,* with doors closed and no natural air movement, the value of air movement can be experienced by persons in the room on comparing the physiological effects with the fan running and without. With the fan running conditions are comfortable. Stoppage of the fan will be followed by a gradual increase in the pulse rate ; rise in the surface body temperature, e.g. on the face ; nasal passages becoming congested and uncomfortable ; head tending to become hot and stuffy, while feet tend to become chilly and cold.

The simultaneous changes in physical characteristics include :— fall in the cooling power values, dry and wet (shown by the Katathermometer) ; wide variation between the temperatures—dry and wet bulb—at the head and floor levels (which is the cause of the "hot stuffy head, cold feet" sensation) ; decreased air velocities (shown by smoke, or measured by anemometer).

Comfortable conditions are restored by re-starting the fan. If the relative humidity is high the value of air movement is even more effectively shown.

(*b*) *At high temperatures*, 80° *to* 90° *F.*, the cooling of the body is effected mainly by sweat evaporation. The value of air movement is therefore the more marked. When the fan is slowed down and stopped there is an increase of visible sweating. If the air is increasingly humidified, sweat evaporation is progressively reduced, and more marked discomfort and strain result. At high temperatures, particularly if the air is very humid, adequate air movement is of primary importance, which can be appreciated by the effects experienced when the fan is restarted and the speed increased.

The physical changes are similar in character to those at ordinary temperatures. In this connection it may be mentioned that the wet Katathermometer is of particular value, since, owing to the high temperature, the dry Katathermometer cannot be effectively used to give accurate results.

(*c*) *At lower temperatures, below* 55° *F.*, any appreciable air movement produces, in most persons, an uncomfortable sensation of cold, as can be shown by starting the fan.

In such circumstances the value of heating by radiation can be demonstrated by switching on the panel heaters. The discomfort is relieved even though the air movement remains as before and the temperature relatively low. By adopting this method of heating in a workroom on cold days the workers can be kept comfortably warm without any need to shut doors or windows and diminish the air movement—a practice which is unhealthy and conducive to the spread of infection, e.g. from colds and coughs, and which in a number of places may interfere with the work.

Physically the effect of heating by radiation is to raise the temperature of a person's clothing and so warm the body. This effect can be demonstrated in a striking manner in a piece of fur exposed to the source of radiant heat. The temperature of the fur will be found to rise rapidly. The amount of radiant heat received at a given point can be measured by means of the Moll Thermopile and Galvanometer.

*Exhibits Contributed by* :—

MORGAN CRUCIBLE Co., London. Electric heaters.
DAVIDSONS, Ltd., Belfast. Electric motor driven fan
ACME ELECTRICAL MANUFACTURING Co., London. Motor starter.
TOWN GAS BOILERS (Bonecourt), Ltd., London. Gas-fired steam boiler.
BAIRD & TATLOCK (London), Ltd., London. Anemometer and Psychrometer.
J. J. HICKS, 8, Hatton Garden, London. Katathermometer.

## Dust in Stone Dressing.

This Exhibit will demonstrate methods, which have been worked out experimentally by representatives of the Mines Research Department and H. M. Office of Works, of preventing the dust generated in stone-cutting processes from being inhaled by the workers.

Dust inhaled in dressing certain kinds of stone is liable to cause silicosis (see under " Silicosis " p. 138).

Pneumatically-operated stone cutting and dressing tools are shown, with a special dust-trapping apparatus. Compressed air for working them is supplied from plant housed in the adjacent building.

The method adopted is to fit, as near as possible to the cutting point of the tool, a hood so shaped as to collect the dust but not to impede the workers' view of the tool point. The hood is connected to an exhaust draught which can be induced both by the discharged air from the pneumatic tool, and by " live " air from the compressor. The dust-laden air from the hood is carried away by suitable tubing to a filter bag placed outside the shed. The bag is constructed of closely woven flannel or other material capable of retaining the fine as well as coarser dust—the finest dust being the most injurious.

*IN BASEMENT.*

# DUST EXPLOSIONS.
# GAS AND VAPOUR EXPLOSIONS.
## (Screen XXXI.)

The possibility of a severe explosion through the ignition of a dust cloud by a naked light or spark is always present in a factory or warehouse where carbonaceous dust is produced, or even some kinds of metallic (e.g. aluminium) dust. This danger is not generally recognised, although several explosions are reported every year. During a period of seven years, 39 such explosions came to the notice of the Factory Department, causing 5 deaths and, in some of the cases, much damage to property. Of these, malt dust caused 7, sulphur 6, coal and seed 4 each, grain-flour and dyestuffs 3 each, cork, ebonite and aluminium 2 each, rubber, pitch, sugar, linoleum, spent oxide and oatmeal 1 each.

It is important to bear in mind, first, that it is when the dust is raised as a cloud that risk of explosion occurs, and secondly, that what is in the beginning a small explosion may be greatly increased in violence by the dust clouds which it raises from beams, rafters, etc.

Photographs of the effects of some serious dust explosions are shown.

The following precautions are recommended :—

(1) Dust should be prevented from escaping into the atmosphere of the work store or other rooms by enclosing all machines, elevators, etc., as far as possible.

(2) The accumulation of dust on floors, machine frames, overhead beams, shelves, etc., should be prevented by systematic cleaning of such places. This may be most effectively done by means of a vacuum cleaner.

(3) Naked lights should not be used in places where dust clouds may arise, and, in the case of disintegrators and grinding mills, precautions should be taken for removing all pieces of flint, metal, etc., as far as possible from the material before it enters the machine, so as to prevent mechanical sparking inside the grinding machines. All electrical apparatus likely to cause sparking should be enclosed by dustproof covers.

(4) An explosion inside the grinding system may be prevented from spreading to other parts of the plant (e.g., dust collectors) by the provision of explosion vent pipes leading to the outside and of suitable rotary valves or conveyor chokes so arranged that the explosion travels through the vent pipes to the outside air.

Some methods of carrying out these recommendations are shown.

Experiments have been carried out for the Home Office at the Experimental Station of the Mines Department to determine the degree of inflammability and capacity to propagate an explosion of the various carbonaceous dusts which are liable to be produced in factories.

Samples taken by the Inspectors in the course of inspection from beams, ledges or other projections in factories, were used for the purpose.

As a result of these tests it has been found possible to make a rough classification of such dusts as follows :—

*Class I.*—Dusts which ignite and propagate flame readily, the source of heat required for ignition being comparatively small (such as a lighted match).

*Class II.*—Dusts which are readily ignited, but which for the propagation of flame require a source of heat of large size and high temperature (such as an electric arc), or of long duration (such as the flame of a Bunsen burner).

*Class III.*—Dusts which do not appear to be capable of propagating flame under any condition likely to obtain in a factory ; either (*a*) because they do not readily form a cloud in air, or (*b*) because they are contaminated with a large quantity of incombustible matter, or (*c*) because the material of which they are composed does not burn readily enough.

The dusts already tested have been classified as follows :—

*Class I.*—Sugar ; dextrine (calcined farina) ; starch ; cocoa ; rice, meal and sugar refuse ; cork ; soya bean ; wood flour ; malt ; oat husk ; grain (flour mill) ; syrolit ; distillery meal ; spice room (cattle food) ; locust bean kernel ; locust meal ; cellulose acetate ; liquorice root ; maize ; tea ; compound cake ; grain (grain storage) ; rape seed ; cornflour ; flour (flour mill) ; chicory ; briquette ; gramophone record ; pitch ; ebonite ; erinoid ; gum gatto (fine) ; mimosa bark ; cascara sagrada ; gentian root (balloon dust) ; rachig ; keronikon ; keronyx ; No. 1 British gum ; No. 2 Cove gum ; spent hops for cattle food (dust escaping from cyclone).

*Class II.*—Copal gum ; leather ; "dead cork" ; cocoanut oil milling ; rice milling ; saw dust ; castor oil meal ; myrabolum and valonia nuts ; paper tube works dust ; yellow meal ; Heycol CA (dye) ; oil cake ; offal grinding (bran) ; grist milling ; horn meal ; mustard ; shoddy ; shellac composition ; gluten feed ; Congo copal dust.

*Class III.*—Organic ammonia ; tobacco ; spice milling ; bone meal ; lamp black ; sack cleaning ; retort carbon ; grain cleaning ; tapioca ; "hooking frame" dust ; Era chrome brown ; Era chrome green ; gum gatto (coarse) ; drug grinding ; cotton seed ; cotton seed and soya bean ; charcoal ; foundry blacking ; brush carbon ; stale coke ; plumbago ; bone charcoal ; mineral and ivory black ; rag paper works dust ; Alizarine yellow "G" ; Anachrome Brown ; spent hops for cattle food (before disintegration).

The Exhibits include :—

(1) Baffle for malt mill, showing method of choking an explosion at the rolls.

(2) " Ringrose " Lamp for indicating the presence of inflammable and explosive gases.

(3) Faulty " safety " lamp, the perforated gauze of which led to a fatal accident.

(4) Sections of good type of blow lamp for petrol and paraffin.

(5) Good and bad types of reducing valves for oxygen cylinders.

(6) Safety valves for ammonia or carbon dioxide compressors.

(7) Acetylene :—

(*a*) Hydraulic valve of good design.

(*b*) and (*c*) Hydraulic valves of faulty design.

(*d*) A portable Acetylene Generator which exploded.

(8) Metal (nails, etc.) collected in a cork grinding works in one hour by electro-magnets from cork chips before the chips passed into the disintegrator.

(9) Steam jet nozzle for use in scavenging mains in blast furnaces.

(10) Bronze pointed tool for opening carbide drum.

(11) McLuckie Gas Detector calibrated for methane.

(12) Wooden keg showing danger from spontaneous combustion of rags damp with turpentine and printers' ink.

(13) Photographs (on Screen XXXI) showing effects of explosions from gases, vapours and dusts in various industries, and methods of prevention.

(14) Apparatus for demonstrating explosibility of different dusts. (In room adjoining lecture room.)

(*See also* Cellulose Lacquer Spraying Exhibit on ground floor—page 41, and Coal Gas Detector in Case X in Gallery.)

# FACTORY HEATING.

The exhibit is intended to illustrate the factors which require to be taken into account in planning the heating arrangements of a factory or other industrial premises.

The Factory Acts require that adequate measures must be taken to maintain a reasonable temperature in each workroom, and the measures taken must be such as not to interfere with the purity of the air of the room.

No definite standards have so far been laid down. What is a reasonable standard in a given case will depend on the nature of the work, whether sedentary, or one involving moderate or great exertion, and other factors, In general, it is recognised that for sedentary work, 60° F. is the temperature which should be maintained.

The planning of heating arrangements adequate to warm a factory is a matter which, if results, satisfactory from the point of view of the worker and the work, and at the minimum of expense to the employer, are to be obtained, requires to be studied from several different points of view, and involves knowledge, for instance, of the physiological principles underlying the sensations of warmth and cold, and of the physical principles underlying the transmission of heat, as well as what may seem the more practical questions of the type of heating apparatus and kind of fuel to be employed.

The factors mentioned are dealt with in four sections, namely :—

I. Physiological.
II. Constructional.
III. Fuels.
IV. Heating Apparatus.

The exhibit consists of a number of charts and instruments and of drawings and photographs of heating apparatus.

The following notes will indicate briefly how they are treated :—

I. *Physiological.*—Modern research has thrown much light on this aspect of the subject, and the exhibit explains and illustrates in particular, the principles of loss of body-heat, the effects of cold surfaces in intensifying heat loss, the limitations of the thermometer as an indicator of " comfort " standards, and the new instruments which take both " convection " and " radiation " into account (Katathermometer and Eupathioscope).

II. *Constructional.*—The physical laws of heat transmission—conduction, convection and radiation—are dealt with so as to make it clear how, and to what extent, a building loses heat to the outside, and how it receives heat from the heating apparatus. In connection with " conduction," the heat losses of particular types of construction, and in connection with " radiation " the principles of panel heating, are dealt with, together with the calculation of the heating power required.

III. *Fuels.*—Charts are shown giving the average calorific values of various fuels and their " thermal costs."

IV. *Heating Apparatus.*—Systems of industrial heating, and apparatus of different kinds, are described and illustrated from the stand-point of the heating engineer. Boilers and other heat sources, e.g., calorifiers and refuse destructors ; the advantages and disadvantages in practice of the various boiler fuels available (solid, liquid, gas), and the importance of maintaining the thermal efficiency of boilers by preventing unnecessary losses, are dealt with. The various types of central healing systems in common use—both direct (hot water, low pressure steam) and indirect (warmed air)—are illustrated, and their several advantages explained. Automatic regulation of heating apparatus is also described.

*"LIGHTING" ROOM.*

# PRINCIPLES OF LIGHTING.

## Importance of Good Lighting in a Factory.

Within recent years factory lighting has come to be recognised as a very important section of industrial hygiene, and the large amount of investigation and experiment that has taken place has established clearly that good lighting has a marked influence both on the safety, health and comfort of the worker and on the ease and efficiency with which the work can be done.

(i) *Accident incidence* has been found to be closely related to lighting. A statistical investigation made by the Departmental Committee on Factory Lighting in 1914 showed that the frequency of certain kinds of accidents is nearly 50 per cent. higher during the winter months, when many working hours are spent under the relatively low artificial illumination, than during the long days of summer.

(ii) *Cleanliness and the maintenance of hygienic conditions generally* are greatly assisted by the provision of good light, which not only acts as a germicidal agent, but also tends to prevent the unnoticed accumulation of dirt and waste.

(iii) *Discomfort and eyestrain* are often caused by insufficient or badly arranged lighting. Further, in certain processes the detail to be discerned is so fine that even when the illumination is good, the eye must still be brought near to the work, with the result that certain muscles of the eye have to be continuously in action. Quite recent investigation tends to show that in such instances great relief can be afforded by the use of specially designed spectacles. In "linking," a very fine process in hosiery manufacture, the use of such spectacles has not only been greatly appreciated by the operatives concerned, but has been followed in each instance by a distinct increase in the output produced. (Exhibits 9 and 20.)

(iv) *Production* has been shown to be greatly influenced by the lighting conditions. In fine weaving, for instance, output has been found to be about 10 per cent. less during hours of artificial light than under the higher illumination of daylight, and in hand-composing (printing) output improves in quality and quantity as the illumination increases up to a limit which is much higher than that commonly adopted in practice.

## How to Secure Good Lighting in a Factory.

The first question to be considered is, what is the amount of illumination required for the purposes of the factory. Clearly, there can be no general reply expressed in numerical terms, since almost every process has different requirements, and each must be considered on its merits. Certain broad rules, however, can be laid down. The illumination should be adequate in two respects :—

(*a*) for affording safe and convenient access from one part of the factory to another ;

(*b*) for the effective performance of the actual work.

For (*a*) certain minima (varying from 0·05 to 0·25 foot-candles) have been recommended by the Factory Lighting Committee.

As regards (*b*) much further experiment is needed before a final answer can be given ; but the same Committee have specified certain values as minima below which the illumination should not be allowed to fall. These are 3 foot-candles for " fine " processes, and 5 foot-candles for " very fine " processes. The foot-candle is now universally used as the unit of measurement of illumination. (*See* below.)

In the present exhibit arrangements have been made to reproduce these and other illuminations for demonstration purposes (Exhibits 1, 9 and 10). It must, however, be remembered that " illumination " is measured in terms of the amount of light *received* on a surface and is the same whether, for instance, the surface is white or black. In practice, however, " brightness," which is measured by the amount of light *returned* from the surface, is more important and this depends not only on the illumination but also on the colour or " reflection factor," so that the darker the colour or the lower the " reflection factor " the higher is the illumination required to produce a given brightness. (Exhibit 3.)

Secondly, apart from the actual illumination, certain conditions must be fulfilled, as follows :—

(*a*) *Constancy and uniformity,* and in particular the avoidance of any flicker at the sources.

(*b*) *Absence of glare,* whether this arises from an unshaded part of the source being placed in or near the line of vision (Exhibit 14), or from a reflection of the source in shiny or polished material (Exhibits 7, 8 and 13.)

(*c*) *The elimination of troublesome shadows,* whether of the worker himself or of parts of the machinery or plant, or of the material being worked upon (Exhibit 5); and the retention of useful shadows. (Exhibit 6.)

(*d*) The attainment of maximum lighting efficiency by keeping the light sources and fittings clean and renewing the former when necessary (Exhibits 11 and 12), by maintaining the walls and ceilings clean and light in colour (Exhibit 18), by maintaining the windows in a clean condition (Exhibits 22 and 23), and by removing obstructions between the light sources and the place of work.

In addition, the *composition* of the light is important in certain processes, e.g., where colour matching is involved. (Exhibits 24 and 25.)

THE EXHIBITS are as follows :—

(The numbers, excepting 21, are the numbers of the separate cabinets.)

(1) *Demonstration of various Illuminations.*—The unit of illumination is the foot-candle and may be defined as the illumination of a surface placed normally (i.e., at right angles to the direction of the light) at a distance of one foot from a " point " source of one candle power. In this exhibit a white surface is illuminated by a concealed light source, the distance of the source from the surface being adjusted by means of a traveller. The illumination in foot-candles at any point can be read from the external scale.

It will be noted that when the distance between the surface and the source is doubled, the illumination is not halved, but reduced to one-quarter ; or, to state it in general terms, that the illumination varies inversely as the square of the distance between the source and the surface.

(2) *Portable Photometers,* which enable the illumination at the work-place to be readily ascertained and checked from time to time.

*Lent by—*
EVERETT EDGCUMBE & Co., Hendon.
BENJAMIN ELECTRIC Ltd., London.
HOLOPHANE, Ltd., London.

(3) and (4) *Effects of Colour* (*Reflection Factor of the Material*).—*Illumination* being the amount of light *received* on a surface is independent of the nature of the surface, and is the same whether the material is white or black.

*Brightness* is measured by the amount of light *returned* from the surface, and is the most essential factor in industrial work, since the power of seeing depends mainly on the amount of light reaching the eye from the surface.

Exhibit 3 contains white material, reflecting about 80 per cent. of the light received; Exhibit 4 contains dark material reflecting about 8 per cent. of the light received. In order to make the brightnesses identical, the illumination on the dark material has to be ten times that on the white.

(5) *Effect of Shadow.*—Shadows may be a serious *hindrance* to good work, and the importance of suitable positions of the light sources is illustrated in this exhibit. The light above the machine throws the shadow on the working area. By altering its position to the left centre of the bench this shadow is eliminated, and in addition, illumination is provided for a similar machine on the opposite side of the bench.

(6) *Effect of Shadow.*—Shadows may be an important *aid* in the discrimination of detail, as in the case of the articles shown here. If the lamps are wrongly placed, suitable shadows are not formed and the detail of the objects is difficult to distinguish. Operate both switches and note that the detail almost disappears. Switching off either set of lamps enables the detail to be easily seen.

(7) and (8) *Effects of Direct (Specular) Reflection.*—A ray of light striking a perfectly polished surface such as a mirror is reflected from the surface at the same angle. (Exhibit 7).

This law of reflection has an important bearing on processes involving the use of shiny polished material, which acts to some extent as a mirror.

In Exhibit 8, the lamp illuminating the photograph or engraving plate is wrongly placed because the light is reflected directly along the line of vision. The unpleasant dazzle can be avoided by tilting the plate (or moving the lamp). (*See also* Exhibit 13.)

(9) and (10) *Exhibition of certain Illuminations.*—In Exhibit 10 the illumination is 3 foot-candles, the minimum suggested by the Factory Lighting Committee (1922) for "fine work" (examples exhibited). In Exhibit 9 the illumination is 5 foot-candles, the minimum suggested by the Committee for "very fine work." The samples of work exhibited show that these illuminations are barely adequate, and in actual practice a much higher standard of illumination should be used. The diagrams show that increased output has been obtained with increased illumination.

(11) and (12) *Effect of Dirty Fittings and of Blackened Lamps.*—The lamps, clean and dirty, in Exhibit 11, and the clean and dirty fittings for semi-indirect lighting in Exhibit 12, are respectively of the same candle-power. A comparison between the lighting efficiency of the clean and dirty sources illustrates the importance of systematic attention to cleaning and to replacement of blackened lamps.

(13) *Effect of Reflected Glare.*—The reflected glare and dazzle from the polished engraved plate are avoided by interposing the tracing cloth screen between the light source and the work.

(14) *Effect of Glare.*—A bright unscreened source of light in or near the line of vision, has a dazzling effect which fatigues the eye and interferes with distinct vision.

Fine detail is easier to discriminate when the light is well above the line of vision or is screened so as to prevent direct glare.

The exhibit shows lettering to be read (*a*) with blind up, and (*b*) with blind just screening the lamp and thus preventing the glare.

(15) *Effect of Illumination on Rate of Perception.*—The formation of a clear image of the work by a man operating a machine is of importance from the point of view of safety. The formation of a clear image of an object depends upon (1) the time it is exposed to view, and (2) its illumination. In this exhibit the time of exposure is constant, and the illumination variable. The images appear fogged with low illumination, so that the speed of the disc is apparently increased.

(16) ————

(17) *Adjustable Fittings.*—Satisfactory illumination is often difficult to obtain just where it is needed unless a lamp mounted on an adjustable bracket is used. Exhibit 17 shows a number of adjustable *bracket* fittings suitable for fixing to walls or back of benches, and Exhibit 20 shows similar fittings of the *standard* type for fixing to benches or tables.

*Lent by*—

J. DUGDILL, Ltd., Birmingham.
PURIT SPECIALITIES, Ltd., Birmingham.

(18) *Effect of Wall Material.*—The reflection factor of walls depends upon their colour and the nature of their surface (i.e., matt or glossy), and has an important effect on the interior illumination secured from a given lighting system, especially in small rooms. In this exhibit the illumination in the centre is reduced from 9·8 foot-candles with white walls to 3·6 foot-candles with dark blue walls. The exhibit also illustrates the necessity of keeping white walls clean and free from dust.

(19) Method of providing local light for a sewing machine from a low voltage supply. This would be used where good general overhead lighting was also provided.

*Machine and Light lent by*—LOTUS Ltd., Stafford.
*Reflector lent by*—WARDLE ENGINEERING Co., Trafford Park, Manchester.

(20) *Adjustable Fittings.*—Satisfactory illumination is often difficult to obtain where it is needed except with lamps mounted on adjustable *standard* fittings, suitable for fixing on benches or tables. Similar fittings of the *bracket* type suitable for fixing to walls or back of benches are shown in Exhibit 17.

The process of linking in hosiery manufacture is a good instance of the need of this kind of illumination. The process is shown in the photograph and the actual machine on which the work is done is also shown. A specimen of the work is seen in Exhibit 9. For the process of linking, the light source should be arranged so that the maximum illumination is provided on a nearly horizontal plane. This can best be done by the use of adjustable standard or bracket fittings which can be moved out of the operative's way during daylight, as shown in the photograph.

Further, even with good illumination, it may be impossible to eliminate eyestrain in very fine work of this nature, and the use of *special glasses* (similar to those shown in Exhibit 9) is recommended. In recent experiments such glasses have effectively reduced eyestrain, and have not only been greatly appreciated by the operatives, but have resulted in an increase of production in every case. *See* Reports Nos. 40 and 49 of the Industrial Fatigue Research Board, "The Effect of Eyestrain on the Output of Linkers in the Hosiery Industry," and "On the Relief of Eyestrain among Persons Performing very Fine Work," published by H.M. Stationery Office.

*Adjustable fittings lent by*—J. DUGDILL, Ltd., Birmingham.
*Linking Machine lent by*—B. HAGUE & Co., Nottingham.

(21) *Exhibit of Lamp Fittings* (*Ceiling*).—A large number of lighting fittings are shown. The importance of avoiding glare (*see* Exhibit 14) and the desirability of using to the best advantage all the light given by a lamp, has led to the almost universal adoption of well-designed shades and reflectors in modern lighting practice.

(22) The exhibit represents two rooms which are deep compared with their height. In one room the effect of dirt on the window glass can be seen by the alteration of illumination produced when dirty glass is moved across to cover the windows.

In the other room the effect of lowering the window can be seen. The top of the window provides most of the illumination at the back of a deep room, and the importance of carrying the windows right up to the ceiling and of avoiding obstructions due to the bottom portion of blinds left unrolled can readily be seen.

The illuminated apertures in the tables form a rough photometer. The value marked against the aperture which appears to be of the same brightness as its background, is the value of illumination at the table.

(23) This exhibit represents a room lighted by a "saw-tooth" roof giving north light. Comparison of this room with those in Exhibit 22 indicates the advantage of roof lighting in securing even illumination over the area of work.

(25) and (26) *Effects of Composition of Light.*—Owing to the difference in the spectral composition of ordinary artificial light as compared with daylight, colour discrimination is greatly modified when a change is made from one to the other. Slight differences in colour are often not apparent when ordinary lamps are used, but may become so when blue-bulbed lamps or special "daylight" units are substituted.

*Fittings lent by—*

SHERINGHAM DAYLIGHT LAMP Co., 11, Edith Villas, West Kensington, W.14.

BENJAMIN ELECTRIC MANUFACTURING Co., Tariff Road, N.17.

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## PHOTOGRAPHS.

Good and bad lighting installations in factories.

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*ROOM NEXT TO LECTURE ROOM.*

## NOISE INSULATION.

It is only within quite recent times that attention has begun to be given to the effects of noise on the health and efficiency of the worker, and by consequence on the quality and quantity of his work. It is now generally believed that constant exposure to excessive noise causes discomfort and fatigue which have an injurious physical effect. Scientific research into the subject is being pursued, and various methods are being tried in industrial and business premises for reducing noise. One of these is illustrated in this room.

Sound waves in a room or other enclosed space are reflected from the walls and ceiling so that a person in the room receives from any source of noise in the room both direct and reflected sound waves. It follows, that if the greater part of the reflected waves can be absorbed, a considerable reduction in the volume of noise is obtained.

The ceiling of the room is lined with a padding made of special seaweed from Nova Scotia, stitched inside an envelope of brown paper. This padding is afterwards covered with stretched canvas, which can be coloured if desired. Only half the ceiling is covered with canvas, in order to show the padding.

Though to produce the best results the walls should also be lined, the effect of the device can be judged by comparing the volume of noise produced by a pneumatic tool on an iron stool in this room with the volume of noise produced by similar means in the adjoining Electric Control Room which is of a similar size but not insulated.

*Exhibits lent by* :—
*Noise insulation*—MAY ACOUSTICS Ltd., South Wimbledon, S.W.19.
*Pneumatic Tools*—HOLMAN BROTHERS LIMITED, London.

**Electric Welding**—*see* page 100.

**Lead Paints**—*see* page 136.

# ADDENDUM.

## PRINTING MACHINERY (see page 56).

### Paper Cutting Guillotine.

Very severe accidents, sometimes involving loss of both hands, occur from time to time on paper cutting guillotines. Accidents are sometimes due to one hand being under the knife when the machine is set in motion by the other hand; more frequently, however, they are caused by the knife "overrunning" or "repeating." An overrun takes place immediately after the completion of an ordinary stroke; the knife unexpectedly descends again just at the moment when the operator is liable to place his hands under it to remove the cut paper. A "repeat" stroke is generally due to the partial or complete seizure of the clutch or flywheel, and may take place at any time without warning.

Automatic guarding of these machines is secured in two ways. The machine exhibited is fitted with attachments to demonstrate the first of these methods.

(*a*) With this method a bar sweeps towards the operator at every stroke of the blade, whether it is a normal stroke, or an overrun or repeat stroke, and travels a sufficient distance to ensure that the operator's hands will be removed from under the blade when it begins to descend. It is important that the whole forward movement of the guard should take place during the early part of the down stroke of the knife.

As a variation of this method the push-away bar rests along the front edge of the table and travels upwards and outwards as the knife descends, so pushing the operator bodily away from the machine. Such guards enable material to be kept piled up on the table of the machine, if desired.

(*b*) With the other method there is a series of vertical bars or a grid, combined with (1) some device to prevent an overrun or repeat stroke, or (2) a push-away guard which operates only in case of an overrun or repeat stroke. When the machine is set in motion the grid bars fall close to the blade either on to the top of the paper being cut or on each side of the paper, resting just clear of the table, and so form a screen which prevents the hand from being put under the blade. Machines fitted with this type of guard must be provided with a device requiring the operator to use both hands to start the machine, so that one hand cannot be left under the blade or bars when they fall.

Photographs of paper cutting guillotines, which comply with these requirements, are shown on the screens.

*Guards Lent by the following Firms :—*

UNIQUE ENGINEERING Co., Ltd., " Todd's Guilguard," Torrens Works, Torrens Street, City Road, E.C.1.

USHER-WALKER, Ltd., " Usher Walker," Great New Street, E.C.4.

HAMPSON, BETTRIDGE & Co., Ltd., " Forman," 2–4, Fann Street, Aldersgate Street, E.C.1.

JAMES TRUSCOTT & SON, Ltd., " Truscott," Suffolk Lane, Cannon Street, E.C.4.

MACHINERY MANUFACTURING Co., " Henderson," Restalrig, Edinburgh.

HARRILD & SONS, Ltd., " Harrild," Fleet Works, Norwich Street, Fetter Lane, E.C.4.

HOLMES & Co., " Holmes," Crescent Wharf, Cambridge Street, Birmingham.

G. A. HARVEY & Co., Ltd. (Wire Guard), Greenwich Metal Works, S.E.7.

J. P. UDAL, 45, Upper Dean Street, Birmingham, " Udal."

ROLO, Ltd., Vaughan Road, Leicester, " Rolo."

Photographs of other types of guards are shown on the nearby screens.

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# NOTES

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## PUBLICATIONS RELATING TO INDUSTRIAL MANAGEMENT

### *Industrial Safety*

Industrial Accidents. Illustrated Descriptions of certain Accidents notified to H.M. Inspectors of Factories. Published Quarterly. 3*d*. (4*d*.)

### *Factories and Workshops*

Annual Report of the Chief Inspector. 1933 (Cmd. 4657). 2*s*. (2*s*. 2*d*.)
Factory and Workshop Orders. 1933 Edition. 4*s*. (4*s*. 5*d*.)
Dust in Card Rooms in the Cotton Industry. Report of the Departmental Committee, October 29, 1931. 1*s*. 6*d*. (1*s*. 8*d*.)
Departmental Committee on Compensation for Industrial Diseases. 1st Report, November 16, 1931. 4*d*. (5*d*.) 2nd Report, June 12, 1933. 6*d*. (7*d*.)

### *Welfare Pamphlets*

First Aid and Ambulance for Factories and Workshops. Second Edition, 1929. 4*d*. (5*d*.)
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### *Safety Pamphlets*

Fencing and Safety Precautions for Transmission Machinery in Factories. 1929. (Third Edition.) 9*d*. (11*d*.)
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Fencing and Safety Precautions for Cotton Spinning and Weaving Machinery. Part I. 1920. 1*s*. (1*s*. 1*d*.) Part II. 1920. 1*s*. (1*s*. 1*d*.) Part III. 1921. 1*s*. (1*s*. 1*d*.)
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